Water Resources

Teacher's Introduction to Kentucky's Water Resources

Water Quality Improves, But Problems Still Great

Kentucky's rivers and streams have been among the primary attractions for people throughout our history. The great rivers, streams, and underground springs quenched the thirsts of Indians, settlers, and a variety of animal species for centuries and were the location of various settlements during ages past. Great mussel mounds can be found along riverbanks where Kentucky's residents for thousands of years feasted on the delicate mollusks and fish that inhabited the sparkling waters. As one travels across the state, remnants of limestone springhouses attest to the settlements built around the bubbling cool spring water from beneath Kentucky's land.

Kentucky's water needs and resources changed during the last 300 years as the state was settled. The plentiful supply of water has been misused and abused. The critical vast underground water sources which course under the limestone rock became an unintentional dumping ground for Kentuckians' waste. Water pollution became a problem in more and more drinking water wells and waterways. By the early 1970's more than 70% of our rivers and streams were unfit for swimming, fishing, and drinking due to pollution.

Today, Kentucky's water is cleaner than it was 20 or even 10 years ago due to the Clean Water Act of 1972 and state laws that placed controls on pollution sources. Public and private investments made to protect water resources are paying off. Many streams have improved dramatically as a result of pollution control laws and regulations. However, poor water quality is still impacting more than one-third of the rivers and lakes that are monitored in Kentucky.

Benjamen Franklin once said "We don't know the value of our water until the well runs dry." It is up to all of us to work to protect our water resources both now and for future generations. But first we need to become better informed about our water resources and their many pollution threats. The following activities will help your students understand and better appreciate our water resources. They will utilize math, science, writing, and critical thinking skills to find solutions to the water quality problems that exist in Kentucky.

ν Where To Get Information

The "State of Kentucky's Environment" report contains information regarding rivers, streams, lakes, groundwater, drinking water, and related issues. Many easy-to-interpret charts and graphs are included, providing information specific for the state's 13 major river basins. Check the index in the report for general information and the expanded index in the Appendix of this guide to find a list of all the references to your county and region.

ϖβ Overview of Student Activities

Activity 1: Your Water Resources

Students will conduct a general investigation of statewide and local water quality problems and needs. They will identify their river basin, its pollution problems, and solutions needed to address them.

Activity 2: When the Creek is Your Neighbor

This activity provides an in-depth investigation of local water quality issues. Students research, both collectively and individually, the real-world problems impacting their hometown water resources. This activity is a follow-up to Activity #1 and includes a field activity.

Activity 3: Wastewater: Where Does it Go?

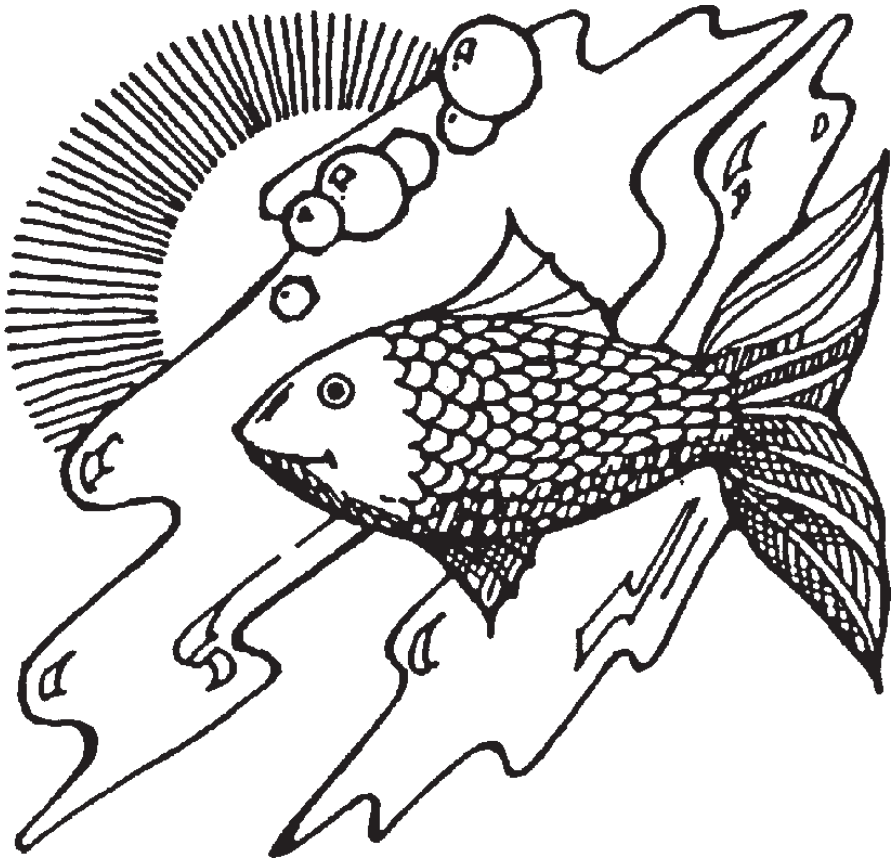
In this activity students will research how their wastewater is treated, where it is disposed, and statewide and local problems caused by improper treatment. Students will analyze how their actions contribute to water pollution problems in Kentucky.

Activity 4: Understanding Groundwater

This activity provides students an opportunity to explore groundwater issues and compare data and information regarding statewide groundwater trends and local problems.

Activity 5: Protecting Your Drinking Water

Students will investigate drinking water issues including its source, quality, and threats. Students will work together to learn how decisions are made regarding the protection of their drinking water.



Activity 1. Your Water Resources

Instruction Sheet

DO YOU KNOW. . .

- Why more than one-third of Kentucky's monitored rivers and streams are polluted making them unfit for swimming, fishing, or as a drinking water source?
- In which major river basin you live?
- What are the largest sources of water pollution problems in your area?

Water Pollution: Problems That Affect Us All

On Easter Sunday more than 100 years ago, the Reverend Daniel A. Gaddie baptized 131 people in Beargrass Creek just east of downtown Louisville. Nearly 10,000 people watched.

Some, apparently overcome by the spirit, jumped in.

Just a few Saturdays ago, Carolyn Kelley of Spirit of Love Center in West Louisville, stood next to Beargrass-this time near Big Rock in Cherokee Park-calling on the Lord again. Teenagers from the church, she'd just learned, had been sloshing around in the creek that health officials say can cause serious illness. Kelley summoned the soaked picnickers into a circle, squeezed her eyes tightly shut, raised her arms toward heaven and pronounced: "I declare those bacteria dead in the name of Jesus!" "But," she added after the prayer, "don't go back in the water." (Excerpted with permission from "Some Think Clear Water Means All Clear"-*Courier-Journal*, 9/6/92)

This story illustrates some of the real-world impacts that pollution can have on our ability to use the resources we have for so long taken for granted. Although Beargrass Creek, like many other Kentucky waterways, has pollution problems, citizens along the creek have rallied in support of their stream and are currently developing a strategy to restore its natural status.

Kentucky has 13 major river basins that are made up of thousands of miles of rivers and streams. Land use activities in these "watersheds" influence water quality. Watersheds are areas of land that drain into a river, lake, stream, groundwater, or other body of water. Activities which occur in the watershed such as dam construction, farming, coal mining, sewage treatment, and many other urban and industrial activities often produce pollutants, such as the bacteria that contaminated Beargrass Creek.

Water quality in the state is monitored by the Kentucky Division of Water. The Division determines whether our waterways are safe for their "designated uses" such as swimming, fishing, and drinking water supply. Currently 36% of the rivers and streams monitored in the state are impacted by pollution. This actually represents an improvement since 1972 when 70% of Kentucky's monitored waterways were polluted.

A great deal still needs to be done to restore our rivers and streams so they can all be safely used. It is our responsibility to learn more about water pollution problems in Kentucky so we may begin to solve these problems both at the state and local level.

Purpose:

In this activity you will explore the concept and importance of watershed protection, identify the basin in which you live, and determine the extent of water pollution statewide and in your region.

Procedure

(Note to teacher - Color-coded maps of each river basin in Kentucky are provided with this activity. The maps will help students identify which streams, rivers, and lakes fall within their basin and whether these waterways can be safely used for the designated uses of swimming, fishing, or drinking. Before you begin this activity it would be helpful to obtain a U.S. Geological Service Hydrologic unit map of Kentucky from the Economic Development Cabinet, Division of Research and Planning, Map Sales, 133 Holmes St., Frankfort, KY 40601. The Hydrologic

Instructions continued

Map will help students identify where their county lies within each river basin. The map costs $2.40 and can be ordered by calling 502-564-4715. If you cannot obtain a Hydrologic Map, a list of counties in each river basin is provided on page 4-5 of the Appendix of this guide.)

Part I - Learning More About Your Water Resources
1. Obtain Worksheet #1 from your teacher. Review, discuss, and answer questions.

Part II - Investigating Water Pollution Problems in Your Community
1. Divide into groups and do the following:
   A. List, then discuss all the benefits you receive from your water resources.
   B. List, then discuss the benefits you receive from the services/products related to the various sources of water pollution listed in Figure 4 of Worksheet #1.
   C. Discuss whether you think we can have both clean water and a strong economy.
2. Remain in groups and obtain your color-coded river basin map from your teacher. Check with your teacher or the Hydrologic Map of Kentucky to locate where your county lies within the river basin. If your county falls within two major basins, you can limit the activity to one basin or look at issues for both. Each group should determine which streams in your community and county are polluted and which are clean enough to meet their "designated uses" based on the information shown on the river basin map.
3. Based on the information from Worksheet #1 and information you may have read in the newspaper and learned from television news, each group should analyze what they think the pollution problems are or may be in the rivers, streams, and lakes in your county and basin.
4. Summarize your group's findings including how land use activities in your county might affect water quality in another. Include in the report what a watershed is, which river basin you live in, and the degree of pollution in your basin compared to other basins in the state. Summarize your thoughts regarding whether we can have clean water and a strong economy. Have a representative of your group present the findings to the class.

Part III - Looking for Solutions
1. Each group should select a stream or lake that is in or near your county, or one you are particularly concerned about, that has been designated as polluted on the river basin map. Write a letter to the KY Division of Water, Water Watch Program, 14 Reilly Rd., Frankfort, KY 40601, in standard business format requesting information about the pollution problems and what is being done to address them. It is best to be as specific as possible in your information request .
2. Discuss the responses in class. Identify ways you and your community can become better stewards of your water resources.

Other Activities:

1. Research the history of the federal Clean Water Act and prepare a chronology of the major laws we have today to protect water quality.
2. Sketch your river basin and the network of rivers and major streams in your county. Prepare a three dimensional model of your basin that demonstrates how activities on the land might affect water quality.
3. Invite a representative from local water company, county extension office, Area Development District, or other expert to discuss general water quality issues in your region, what is being done statewide to improve water quality, and careers in this field.

References and Additional Resources:

1. The Kentucky Division of Water can provide you with additional information about your stream, creek, lake, or spring. Contact the Water Watch Program at 14 Reilly Rd., Frankfort, KY 40601, or call 502-564-3410.
2. "Watersheds: Whose Water is It?" is a multimedia educational packet designed for middle-school students. The materials explore environmental, social and cultural issues related to watersheds. Contact Lee Colten, Division of Water, 14 Reilly Rd., Frankfort, Ky. 40601, 502-564-3410 for information.
3. The Kentucky Division of Conservation promotes farmland conservation practices to prevent runoff water pollution from farmlands. For more information regarding how to prevent pollution from agricultural activities contact them at 502-564-3080 or write to 691 Teton Trail, Frankfort, KY 40601, or contact your county conservation or extension office listed in the phone book under county offices.

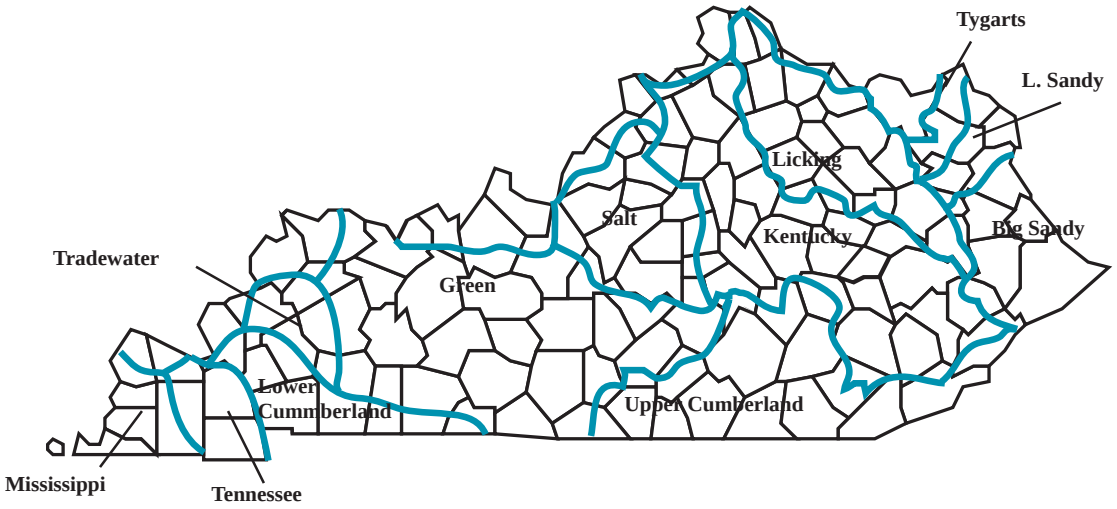
Activity 1. Your Water Resources
Worksheet #1

13 River Basins Provide Kentuckians With Many Benefits

How many miles of streams are there in Kentucky? The answer may surprise you. There are 89,431 miles of streams in the state. If we connected these streams end to end they would circle the Earth's equator three and one half times.

Kentucky's streams help form the state's 13 major river basins (Figure 1). The quality of our waterways is evaluated through 45 monitoring stations. These stations, operated by the Kentucky Division of Water (DOW), along with data collected by other state and federal agencies, provide some insight into the overall degree of stream pollution and the ability of these waters to meet our various "designated uses" including fishing, swimming, and drinking water supplies.

Figure 1
River Basins of Kentucky



Source: University of Kentucky, Department of Geography

Worksheet #1 continued

Many Sources Contribute to Water Pollution

While efforts to control water pollution have improved the quality of many of our waterways, 36% of the 10,659 miles of streams and rivers monitored in the state during 1991 were still impacted by pollution (Figure 2).

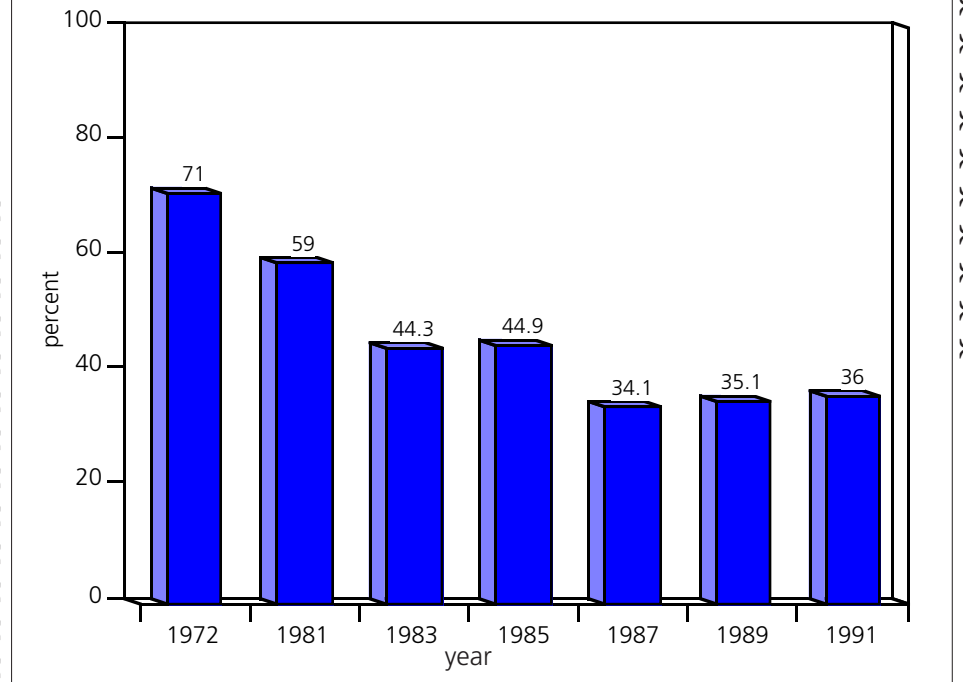
There are many sources of pollution in our rivers and streams that cause them not to meet their "designated uses" of swimming, fishing, aquatic habitat, and drinking water supply (Figures 3 and 4). They include polluted runoff from farms and coal mines, improperly treated sewage, industrial discharges, and toxic chemicals leaking from landfills. State efforts have focused on minimizing the impact of these pollution sources on our rivers, streams, lakes, and underground water resources

Polluted Runoff Impacting Many Waterways

Runoff water pollution, also called "nonpoint source pollution," from agriculture, coal mining, logging, construction activities, landfills, septic tanks, stream alterations from channeling or dredging (listed as habitat modification in Figure 3) and urban runoff from parking lots, stormsewers, and other areas is the primary reason why many of the state's streams and rivers cannot be fully used for fishing, swimming, or as a drinking water supply. These pollutants include topsoil eroded from farmland, animal wastes, chemical residues such as pesticides, nitrates from fertilizers, oil and grease from parking lots, pollution from coal mines and other resource extraction activities, and many additional contaminants that run off the land.

Figure 2

Percentage of Monitored Streams in Kentucky Impacted by Pollution



Source: Kentucky Division of Water 305(b) Reports 1982-1992; U.S. Environmental Protection Agency STEP report, 1972

Worksheet #1 continued

Collectively, these sources are the greatest water pollution problem in Kentucky as can be seen in Figure 3. Nonpoint pollution sources are generally not regulated, making them difficult to control. Efforts to reduce soil erosion on farmland and control runoff from coal mines have assisted in controlling runoff pollution. However, much more needs to be done to address these problems if we are to continue to make progress in reversing the negative trends of water pollution.

Sewage Discharges A Problem, But Controls Are Helping

We produce a great deal of waste in our homes and businesses. Although much of this sewage (also called wastewater) is treated to remove pollutants, improperly treated wastewater from poorly maintained and operated wastewater treatment plants causes many water pollution problems. Millions of dollars in federal grants to improve these plants have helped, but funds to upgrade the plants have slowly dwindled.

Although wastewater treatment plants are continually being upgraded, many do not provide the treatment necessary to fully cleanse wastewater from our homes and businesses. Some of the pollutants eventually are discharged into our streams and rivers. Figure 3 reveals that municipal wastewater plant discharges are responsible for 29% of the water pollution problems in our streams and rivers. Pollution from inadequately treated wastewater can be measured in 12 of the state's 13 river basins. These pollutants were responsible for 27% of the 60,000 fish reported killed as a result of pollution incidents in Kentucky during 1991.

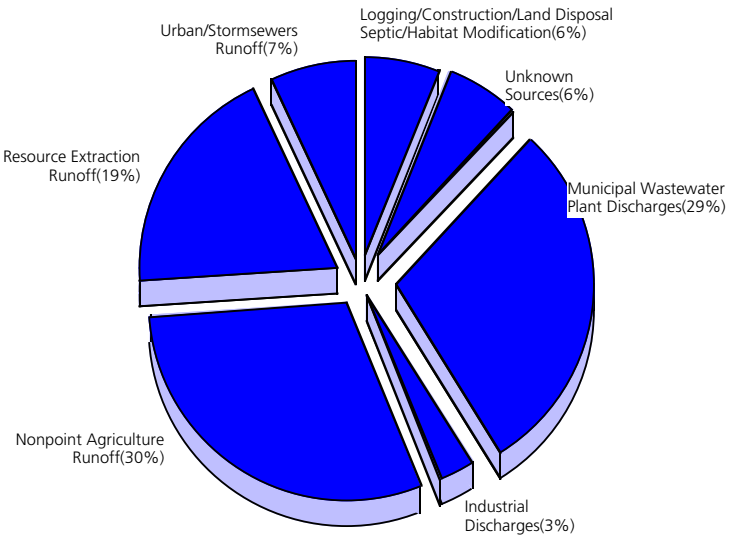
Industries Make Greater Efforts to Control Pollution

Another source of water pollution is discharges from industries. During the manufacture of products, industries often create waste which must be treated before it can be disposed. Most treated wastewater is then discharged into streams and rivers.

Industries are now required to control their discharges into waterways more closely than in the past, but problems still occur that impact the rivers and streams into which they discharge. Figure 3 indicates that industries contribute a relatively small percentage of the pollutants in our waterways.

Figure 3

Sources of Pollution to Rivers and Streams in Kentucky (1991)



Source: Kentucky Division of Water; 305(b) Report, 1992

Worksheet #1 continued

Worksheet #1 continued

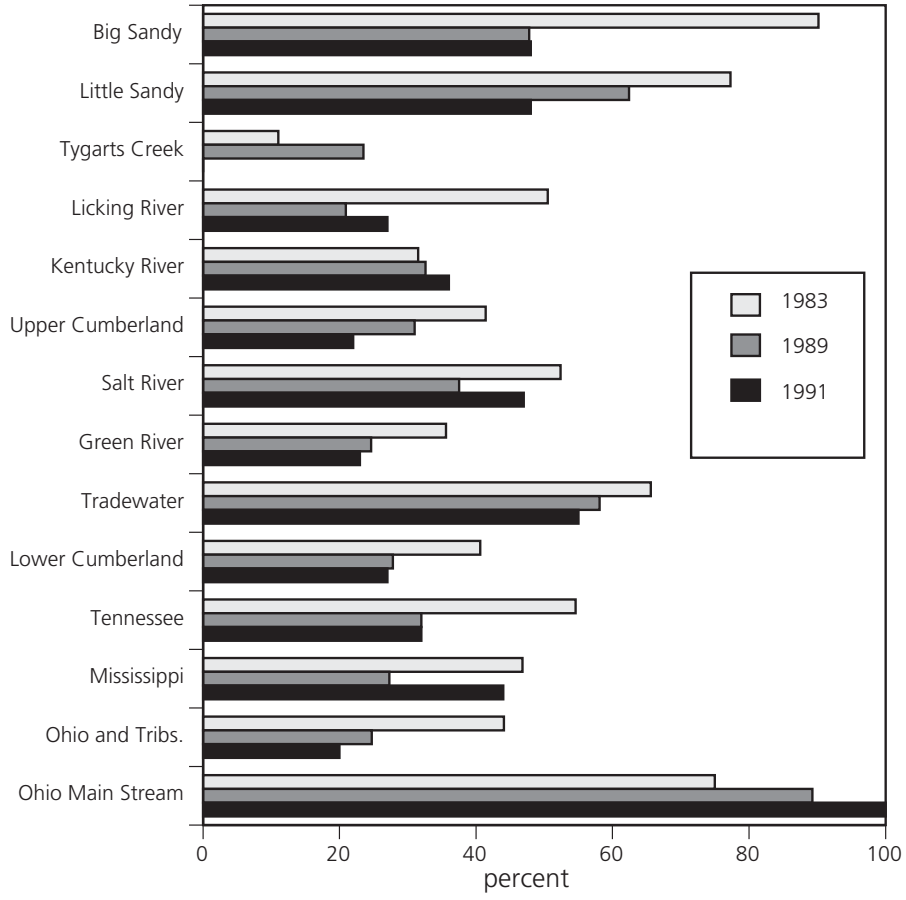
However, this may be misleading since many industries pipe their wastewater to municipal wastewater plants for treatment. Large industries often treat this waste before it is sent to treatment plants but some do not. Many municipal sewage plants are not equipped to adequately treat industrial wastewater, especially when it contains toxic chemicals. These pollutants, along with the treated wastewater, are eventually discharged into streams and rivers.

Water Pollution Laws Focus on Industry and Sewage Treatment Plants

Federal and state government efforts to restore and improve the quality of our waterways have primarily been to control industrial and sewage treatment plant water pollution discharges. Under the federal Clean Water Act passed by Congress in 1972 and later adopted as state law, the discharge of pollutants into the waters of the Commonwealth is prohibited unless a Kentucky Pollutant Discharge Elimination System (KPDES) permit is issued. These permits limit the amount of pollutants discharged, require monitoring, and must be renewed at least once every five years. KPDES permits are in effect for 3,023 industries and sewage treatment plants and approximately 4,100 coal mining operations in Kentucky.

Figure 5

Percentage of Streams and Rivers Assessed in Kentucky with Some Degree of Pollution by River Basin



Kentucky Division of Water, 305(b) Reports, 1982–1992

Worksheet #1 continued

Controlling water pollution through KPDES permits and enforcement of state water laws and regulations has improved the quality of some streams and rivers across the state. Controls have been more effective in some river basins than others as can be seen in Figure 5. We still have a long way to go to clean up Kentucky's waterways.

Questions?

1. List the things you do in your everyday life that contribute to each of the major sources of water pollution shown in Figure 4.
2. Based on the water quality information you have reviewed in this activity, identify in which river basin you would choose to live? Explain your choice.
3. How many fish were killed in 1991 due to pollution from wastewater treatment plants?
4. How has Kentucky tried to control water pollution? How effectively do you think these efforts have protected our water resources?
5. Do you think more needs to be done to protect our water resources? Explain your answer.

What You Can Do...

1. Get Involved. Each of us pollutes our water. Each of us can help clean it up. Our individual efforts may seem small but when we join with thousands of others, a big difference can be made. Your class can organize a stream cleanup to focus attention on your hometown rivers, streams, and lakes. Adopt a stream and form a Water Watch group. You can contact the Water Watch program by calling 502-564-3410 or writing to Water Watch, 14 Reilly Rd., Frankfort, KY 40601.
2. Talk to others about the importance of Kentucky's streams, lakes, and rivers and how it is our responsibility to protect these valuable resources.

Figure 4

Sources of River Pollution in Kentucky

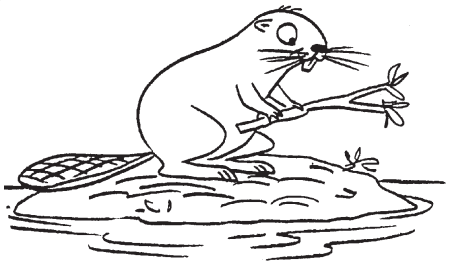
	Point Sources			Nonpoint Runoff Sources						
River Basin	Municipal Wastewater	Industrial	Toxics	Agriculture	Mining	Urban	Oil and Gas	Septic Tanks & Land Disposal	Logging	Construction
Big Sandy	●*			●*	●*	●	●	●	●	
Little Sandy	●*			●*	●		●*	●*		
Tygarts Creek	●			●		●		●	●	●
Licking River	●*		●	●*	●	●*	●	●	●	●
Kentucky River	●*	●	●	●*	●*	●*	●*	●	●	●
Upper Cumberland	●*	●*	●	●	●*	●		●	●	●
Salt	●*	●	●	●*		●*		●*	●	●
Green	●*	●*	●	●*	●*	●*	●*	●		
Tradewater				●*	●*		●		●*	
Lower Cumberland	●*	●		●*	●				●	●
Tennessee	●	●*	●	●		●				
Mississippi	●*		●	●	●				●	
Ohio and tribs.	●*	●*	●*	●*	●*	●*		●	●	●

** Considered a major or moderate source of pollution*

Source: Kentucky Division of Water and ORSANCO 305(b) Report, 1990-1992

Activity 2. When the Creek is Your Neighbor

Instruction Sheet



DO YOU KNOW...

- What the major pollution problems are in your local rivers and streams?
- How water pollution affects your daily life?
- How you can help improve water quality in your community?

Water Pollution Problems Need to be Solved at the Local Level

At 4:15 p.m. on April 7, 1993, Lucian Doyle, a teacher from Fairdale High School in Jefferson County, called the Kentucky Division of Water to report that his students had discovered a serious pollution problem in nearby Wilson Creek. The students had been monitoring the creek for some time and that morning they found that the water's pH had become dangerously high, increasing from a nearly neutral pH of 7.2 to a high of 9.0 during the course of the day.

Knowing that a high pH could be devastating to the stream and aquatic life, as well as harmful to people who might use the water, the students double-checked their results and determined that something was wrong with the water. The students and Mr. Doyle immediately contacted state officials to report their findings. The students' discovery led state investigators to find an illegal discharge from a concrete mixing company located upstream. The company was charged with a violation and ordered to reduce its pollution to safer levels. Without the students' monitoring, this problem would have continued, severely impacting the creek.

Solutions to water quality problems must begin at the local level. People who live near a waterway usually have the most interest in ensuring that the resource is clean enough for swimming, fishing, aquatic life habitat, and as water supply for people, animals, and economic activities. The health of waterways closest to you cannot be maintained by government agencies alone. Individuals and local groups must be actively involved in monitoring waterways and finding solutions to problems that exist.

Purpose:

A great deal of information can be obtained about local water quality by visiting a nearby stream and conducting a simple audit of its condition. The following outdoor activity will enable you to draw conclusions about water quality based on observations and knowledge of local land use activities. People who are informed about state and local water issues will be better equipped to work within their community to find solutions.

Procedure:

Part I - Investigating Your Hometown Water Resources

(Note to teacher: This activity works best as a follow up to Activity 1: "Your Water Resources.")

1. Select a stream, river, or lake, in your community and outline or draw its extended watershed as it enters its river basin.
2. As a class, review Worksheet #1, the stream diagnosis sheet and Worksheet #2, the field data collection sheet, before visiting your selected waterbody. Divide into groups and identify with your teacher what field data your group will be collecting.
3. Visit the waterway you selected. Define the extent of the area where your group will be working. Record your group's information on the field data collection sheet.
4. Review as a class each group's recordings and observations.
5. As a class, create charts and graphs to display the information you collected. (A sample graph is shown on the next page.) Include space in the chart to record data for the next 10 years. Challenge future classes to continue to collect information so a long-term trends analysis can be developed.
6. Each student should prepare a report about water quality in the study area. Relate it to general water quality trends in your river basin and statewide. Include in the report ways you think water quality could be improved.

Instructions continued

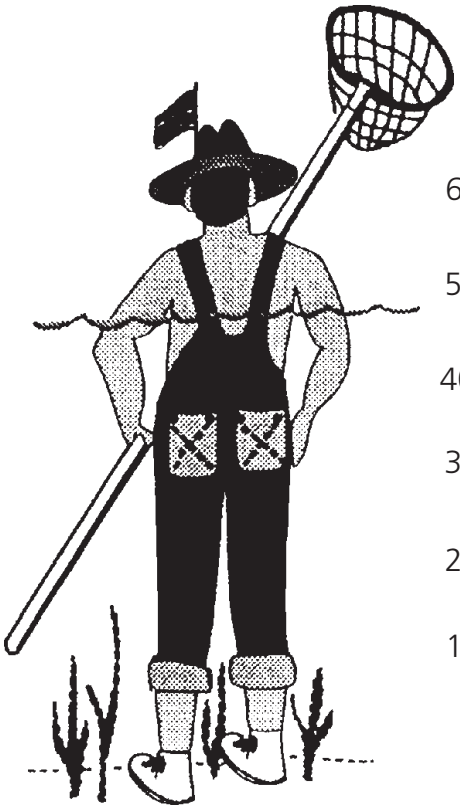
Part II - Going a Step Further
1. Establish a Water Watch group to collect additional chemical and biological data and information on your waterbody.

Other Activities:

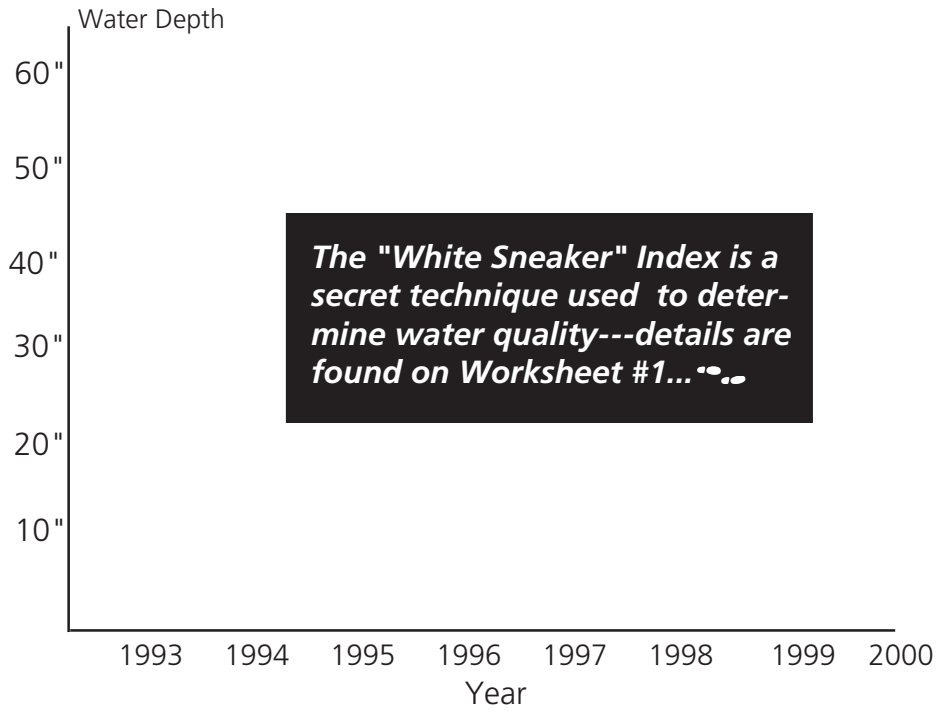
1. Write a "Letter to the Editor" of your local paper and other appropriate agencies and individuals about your concerns/solutions regarding water quality in your local lake, stream, or river.
2. Write an essay that compares two futures. The first "future" describes what water quality in your area might be when you are 30 years old if no one takes action to clean up and protect local waters. The second "future" reflects the likely changes in water quality and related issues when you are 30 years old if you work with others to develop a focused strategy to clean up and protect local waters.

References/Additional Resources:

1. The stream diagnosis sheet in this activity was adapted from: "A Field Guide to Kentucky Rivers and Streams." For a copy of this guide or to find out more about how to adopt a stream or lake contact Water Watch, Kentucky Division of Water, 14 Reilly Rd., Frankfort, KY 40601, or call 502-564-3410.



The "White Sneaker Index*" for Brushy Creek (sample chart)



The "White Sneaker" Index is a secret technique used to determine water quality---details are found on Worksheet #1...

* adapted from Chesapeake Bay's *Bernie Fowler's White Sneaker Index*

Activity 2. When The Creek Is Your Neighbor

Worksheet #1: Stream Diagnosis Sheet

Can you tell what might be wrong with your stream, or if it is generally healthy? Just like diagnosing the cause of a pet's sickness, you can consider all the symptoms and signs together and try to determine what might be causing a water quality problem. The following stream diagnosis guidelines will help you assess various types of water pollution problems and the obvious signs of those problems. Read each section before conducting the stream evaluation. Take these guidelines with you when you visit the stream so you can refer to them while collecting field data.

Characteristics of Surrounding Area Draining Into a Waterbody

The following list describes typical water quality problems associated with the sources shown.

A. Woodland: Check for cloudy or muddy water resulting from erosion caused by logging, road building, mining, etc.
B. Farmland: (crops, pasture and feedlots) Check for excessive algal growth (green water or stream clogged with water plants) caused by fertilizers or animal manure draining into stream. Also watch for soil erosion caused by poor farming practices.
C. Cities and Towns: Runoff from parking lots and storm sewers can carry with it all sorts of pollution including metals (lead), salts, chemicals, and oil. Unhealthy fish populations may be a sign of runoff water pollution from urban areas.
D. Industries: It is often hard to physically detect chemical pollution from industries. If your stream or waterbody is used by many industries it would be appropriate to start a Water Watch group to monitor for chemicals and other pollutants. Excessive algae, odor, absence of animal life, such as insects and fish, and fish kills are problem signs.
E. Sewage: (treatment plants or pipes) Look for "organic" pollution indicated by excessive algal growth, white foam or suds from detergents, absence of fish and insects, and/or extreme abundance of others.
F. Mining: Check for erosion and acid drainage. Acid drainage can be detected by a yellowish-orange deposit present on the bottom of the stream due to high iron content draining from poorly reclaimed mine sites or abandoned mine lands.
G. Construction: Land disturbing activities such as residential development and road building are a leading cause of soil erosion, so watch for cloudy or muddy water.
H. Residential: Lawn fertilizers, detergents used for washing clothes or cars, oil drained from cars, septic tank leakage, and trash (cans, bottles, etc.) are common forms of residential pollution. Keep an eye open for excessive algae growth, white suds, color sheen on surface (oil), or absence of aquatic life.

Physical Indicators of Water Pollution

The following characteristics may indicate that problems exist in your waterbody.

A. Color of stream

1. Green: If the stream is noticeably green this could be an indication of "organic" pollution being released into the stream feeding algae (hence the term algal bloom) and other aquatic plants.
What to do: Check upstream for possible sewage, fertilizer, or livestock waste runoff areas.
2. Orange-Red: Orange to red deposits on stream beds could be caused by iron contained in acid mine drainage from coal mines or runoff from oil wells.
What to do: Check upstream for coal mining or oil and gas drilling. Watch for industrial waste draining into the stream.
3. Light Brown: Sediment deposition (muddy or cloudy) caused by erosion.
What to do: Search upstream for disturbed ground from farming or other activities left bare and susceptible to erosion.
4. Multi-color Reflection: Indicates oil floating in stream.
What to do: Check closely upstream for source. Used motor oil may have been dumped into the stream by an individual or service station. This may also be caused by the improper operation of an oil well.

Worksheet #1 continued

5. White Deposits Along Banks: White, crusty deposits along the edge of the stream may indicate salt pollution from oil well drilling operations.
6. Dark reds, purple, blues, blacks: Indicates organic dye pollution possibly from leather tanning or clothing manufacture.
What to do: Check closely for upstream source, possibly a discharge pipe from an industrial plant.

B. Stream Odor
1. Rotten egg: Indicates sewage pollution.
2. Musky Odor: May indicate presence of untreated sewage, livestock waste, algae, or other conditions.
3. Acrid Smell: May indicate presence of industrial or pesticide pollution.
4. Chlorine: This may mean that a sewage treatment plant or chemical industry is over-chlorinating its effluent.
What to do for 1-4: Check upstream for industrial, municipal, or residential waste entering the stream.

C. Foaming (Suds): White suds greater than three inches high are generally caused by detergents.
What to do: Check upstream for industrial, municipal, or residential wastewater entering the stream.

Fish as Biological Indicators of Water Quality

A. Erratic Swimming: Fish swimming near the surface, gasping for air at the surface, or swimming in circles may indicate the presence of toxic substances or low dissolved oxygen caused by nutrients from fertilizer runoff from farmlands and inadequately treated sewage.
B. Disease: The occurrence of red sores or white, cottony places on fish indicates disease. Disease may be caused by toxic chemicals present at levels not great enough to immediately kill the fish.
C. Absence of Fish: This may be a strong indication of a badly stressed stream. The cause could be urban run-off, sewage, or toxic chemicals entering the stream.
What to do for A-C: Chemical analysis of the water may be needed to find the source, but check upstream to see where the problem begins.

The"White Sneaker Index"

Have your teacher take the first "step" in your stream analysis to determine how clear the water is. Your teacher should enter the stream, lake, or river wearing a pair of "white sneakers," and, using a yard stick, report how deep she or he must go before the sneakers are no longer visible.

Record this information as a part of your charts and graphs (see the example on the instruction sheet). Challenge your teacher to report the "sneaker index" each year to determine if your stream water is getting cleaner or dirtier.

Activity 2: When the Creek is Your Neighbor

Worksheet #2-Field Data Collection Sheet

Record the results of your stream diagnosis below:

River Basin _____

Collectors Names _____

Stream/River/Lake Name _____

Date and Time of Day _____

Stream Location _____

County _____

Weather Conditions:

Conditions (Clear, Cloudy, Rain) _____

Air Temperature_____

Other_____

Physical Appearance of Waterbody: How your waterbody looks may reveal a pollution problem.

1. Water Appearance: (Scum, Foam, Muddy, Milky, Clear, Colored Sheen (oily), Brownish, Other)

_____

2. Stream Bed Coating: (Orange to Red, Yellowish, Black, Brown, None) _____

3. Odor: Rotten egg, Musky, Acrid, Chlorine, None, Other (explain) _____

Habitat Conditions: Clean water is vital for the animals and plants that inhabit your waterbody. But other conditions are also important and will determine what types of species may or may not be present.

1. Circle conditions found at your stream:

Pool (non-moving water)	Eroding Banks	Log piles
Riffle (rapids)	Rock Ledges	Weed beds
Wetlands (marshy areas)	Tree Roots	Large boulders
Stumps	Man-made objects (dams, bridges, etc.)	
Other _____		

2. Estimated Depth: _____

3. Estimated Width:_____

Waterbody Cover: Streamside vegetation is an important component in the overall condition of a waterbody's ability to provide habitat. (check as appropriate)

Stream, River, or Lake is: 1. Fully exposed (0-25% of stream is shaded from the sun)
2. Partially exposed (25% - 50%)
3. Partially shaded (50% - 75%)
4. Fully shaded (75% - 100%)

Worksheet #2 continued

Streamside Vegetation: It is important that streams, lakes, and rivers have streamside vegetation to hold soil in place and filter pollution.

Trees (%) _____ Plants (%) _____ Exposed (%)_____
Shrubs (%) _____ Root mats (%) _____ Other (%) _____

Biological Measures: The number and variety of animals, fish, and plants, or lack thereof, can provide you with important clues to the health of your waterbody. (Circle as appropriate)

1. Algae: Is the algae located everywhere or in spots?_____

   Is the algae attached to the bottom or floating? _____

   Other (explain)_____

2. Fish: Types and number of fish observed (bass, sunfish, etc.) (abundant, sparse, etc.)

   _____

   _____

   _____

4. Other aquatic and semiaquatic organisms observed and number (list):

   Amphibians _____

   _____

   Reptiles _____

   _____

   Birds _____

   _____

   Waterfowl (ducks) _____

   _____

   Mammals _____

   _____

Land Uses in Watershed: The use of the land within your watershed can help you determine what the potential water pollution problems may be. For example if you observed excess algae this may be due to nutrient fertilizer runoff from farmlands. Orange water and sediment may be due to acid mine drainage from coal mines. Stream-side erosion may be caused by grazing cattle or the removal of streamside trees for farming or development. (circle as appropriate)

1. Farming (Pasture/grazing of animals, Crops, Other):_____

2. Urban Areas (Homes, Factories, Stores, Roads): _____

3. Coal Mining or other types of mineral extraction:_____

Worksheet #2 continued

4. Logging: _____

5. Other (explain): _____

Water Uses: You may need to conduct additional research to determine what role your waterbody plays in your community's everyday water uses and needs. (drinking water supply, industrial water supply, agricultural water supply, recreational swimming, fishing, other)

_____

_____

Waste Disposal: Are there any discharge pipes along the waterbody: Yes No

If so, where are they coming from? (check as approriate)
Sewage Treatment Plant
Industry (factory)
Farm Lots
Unknown
Other (explain) _____

Stream Channel Alterations: Alterations to the stream can significantly impact the quality of the resource and its ability to provide habitat to the living organisms dependent on the waterbody. Observe whether the stream has been altered in any way. (check as appropriate)

Dredging (removal of soil to make the waterbody deeper)
Channelization (rerouting the waterbody)
Other (explain) _____

Litter: Litter and garbage dumps are impacting the quality of many streams, rivers, and lakes in Kentucky. Estimate the amount of garbage in and along your waterbody.

1. Number of Paper Items (0-5, 5-10, 10-50, over 50)_____

2. Number of Cans and Bottles (0-5, 5-10, 10-50, over 50)_____

3. Number of Tires, Appliances, etc. (0-5, 5-10, 10-50, over 50)_____

4. Other _____

Possible Pollution Sources: There are many potential sources of water pollution. Try to determine, based on the condition of the waterbody and your general knowledge about various activities in the area, what the potential water pollution sources may be. (Farms, coal mining, oil and gas drilling, logging, urban runoff from parking lots, stores, roads, etc., septic tanks, municipal sewage treatment plants, industry discharges , landfills/garbage, other) _____

_____

_____

Worksheet #2 continued

Site Description: Give a general description of how the stream looks and its general condition. Would you drink the water from this area? Why or why not?

Map of Sampling Location: Sketch the features of the stream including pool-riffle areas, any stream structures, (i.e. bridges, dams), areas of physical impacts, islands, etc. Show dwellings, businesses, roadways, tributaries, direction of stream flow, and a north arrow (N).

Activity 3. Wastewater: Where Does It Go?

Instruction Sheet

DO YOU KNOW. . .

- What causes 29% of the pollution in our rivers and streams?
- How many of Kentucky's 13 river basins are impacted by sewage from wastewater treatment plants and septic tanks?
- What you can do to reduce water pollution in the rivers and streams nearest to you?

Wastewater Among Leading Sources of River and Stream Pollution

Wastewater from our homes, schools, and businesses contains all the materials we flush down the toilet and drains. Wastewater, containing sewage and a variety of other pollutants, typically is discharged to a sewage treatment plant (also called wastewater treatment plants), or a septic tank where it is "treated" to remove the pollutants before it is discharged into a river, stream, lake, or seeps into the ground. Wastewater treatment plants and septic tanks, however, are often unable to remove all pollutants before the water is discharged.

Improperly treated wastewater affects water quality because it contains pollutants that are harmful to the stream's health and impairs our ability to use the water for swimming, fishing, or drinking. These pollutants, such as fecal matter from untreated sewage, toxic drain cleaners, and other products we use in our homes and businesses can wind up in our waterways severely degrading water quality and making it unfit to use.

Kentucky has made some progress in controlling water pollution from wastewater treatment plants by investing millions of dollars to build and upgrade plants. However, these plants are still a leading source of water pollution in the state.

Purpose:

In this activity you will investigate how your wastewater is treated, where it is discharged, and what can be done to reduce water pollution problems caused by wastewater.

Procedure:

Part I - Becoming More Informed

1. Obtain Worksheet #1 from your teacher. Review, discuss, and answer questions.

Part II - Investigating Wastewater Treatment in Your Community

1. Determine if the wastewater from your home is treated:
   - A. By a city, county, or private wastewater treatment plant, which is common in cities and towns.
   - B. By a small package treatment plant, which is common in outlying subdivisions and trailer parks.
   - C. By a septic tank, which is typical in rural areas.
2. Trace and label the path your wastewater takes from the house to its final discharge point.

Part III - Reducing Your Impact on the Environment

1. Identify one product you use regularly in your home that is discharged down the drain or toilet that contains toxic chemicals or phosphates (both of which pollute streams). You can obtain this information by reading the product's label. Identify an "environmentally friendly" substitute for the product.
2. Report your findings to the class. As a class, compile a list of "environmentally friendly" products that can be used in the home and create a school display. Also share your findings with family and friends.

Other Activities:

1. Write a poem entitled "How I feel about the environment."
2. Research the chemistry of wastewater treatment.
3. Interview your grandparents or other older people to discuss how their wastewater was treated when they were young. Discuss the progress we have made in this area.

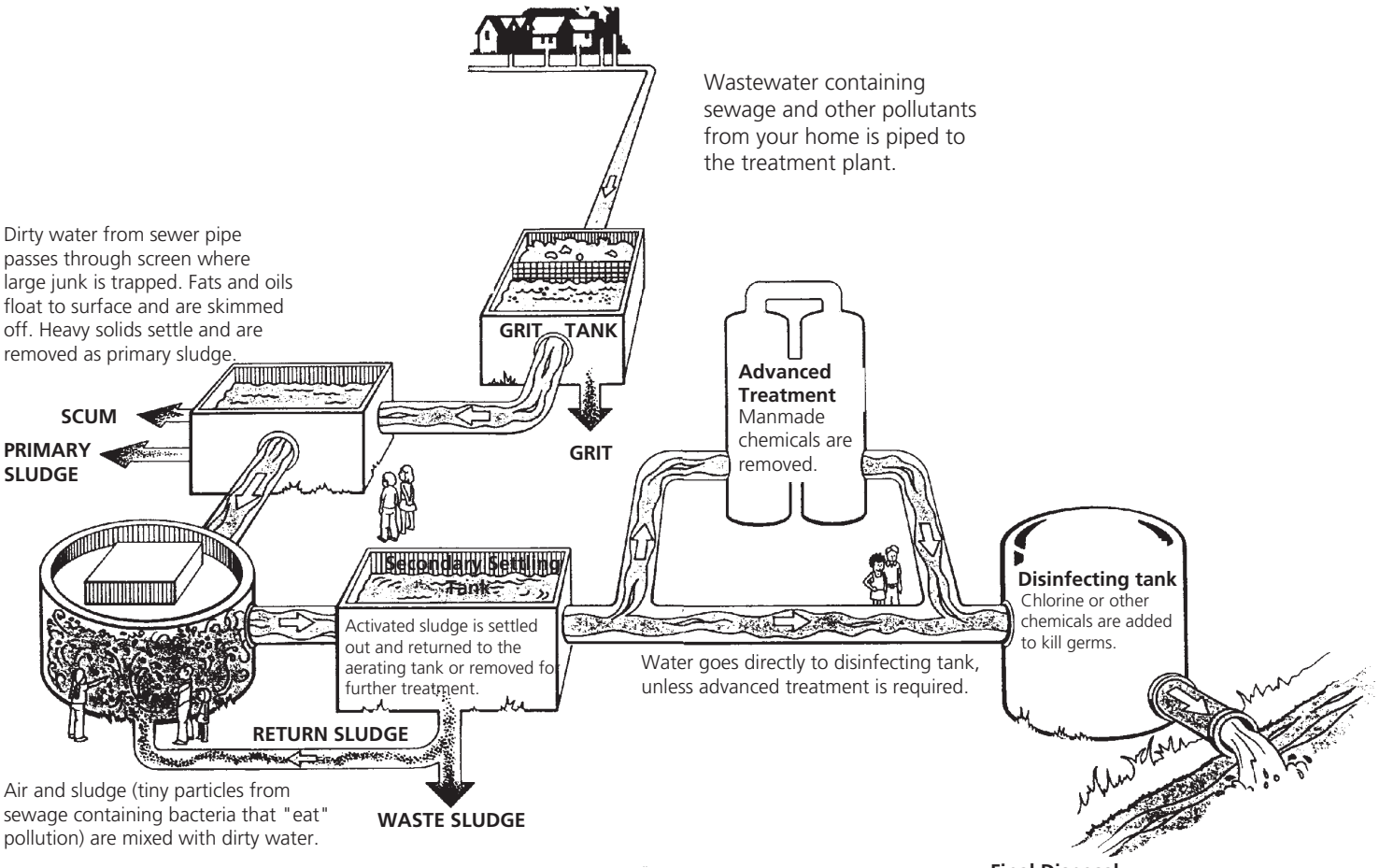
Instructions continued

4. Locate an industry in your community and research how the company's wastewater is treated and disposed during the manufacturing process.
5. Tour you local wastewater treatment plant.

References/Additional Resources:

1. The Kentucky Division of Water, Permit Branch, can provide additional information on wastewater treatment plants in your community. Contact the Division at 14 Reilly Rd., Frankfort, KY 40601, 502-564-3410.
2. The Kentucky Department of Health Services, Division of Local Health, regulates the installation and pumping of septic systems in the state. If you wish to report a problem or find out more about septic tanks call 502-564-4856 or write KY Department of Health, 275 East Main St., Frankfort, KY 40601 or contact your local health department listed in your telephone book.

Wastewater Treatment Plant



Activity 3. Wastewater: Where Does it Go?

Worksheet #1

Sewage is Among Leading Water Pollution Problems in Kentucky

Most of the time we do not think about what happens to our waste once the toilet is flushed. Our sewage usually winds up at a municipal sewage treatment plant where it is chemically treated to remove pollutants and discharged back into a stream, lake, or other waterbody. Wastewater discharges from sewage treatment plants are among the leading sources of stream and river pollution in Kentucky. Discharges of improperly treated sewage from poorly maintained and operated wastewater treatment plants (WWTPs) cause 29% of the pollution problems in our streams and rivers.

Efforts to improve wastewater treatment plants have resulted in some major improvements to the health of streams and rivers during the past decade. Since 1974, $534 million in federal grants, along with state and local matching dollars, have been invested to upgrade wastewater treatment plants throughout the state.

These improvements have helped to reduce violations of water quality standards established to protect public health and the environment. Each plant must apply for and receive a "permit" from the state that establishes limits on the amount of pollution they can release. The percentage of municipal WWTPs that have serious violations with their permit requirements decreased from 30% in 1982, to less than 15% in 1989.

There are an estimated 3,969 municipal, industrial, and small package wastewater treatment plants operating in the state. These include 258 large municipal WWTPs and 1,936 small package treatment plants (Figure 1). Most sewage is treated by the state's municipal WWTPs. These sewage treatment plants can remove about 90% of the wastewater's pollutants. The rest, however, is ultimately discharged into receiving waters where it can degrade water quality.

Although water quality in many streams and rivers has improved as a result of upgrading WWTPs and controlling waste discharges, poor operation and maintenance at of some of these plants continue to contribute much of the bacteria, nutrients, and metals that are polluting Kentucky's streams and rivers.

Figure 1

Kentucky Streams Impaired by Sewage/ Wastewater Treatment Plant Discharges by River Basin

	Wastewater Treatment Plants		Stream Miles Impacted		% of Pollution Problem
River Basin	**Municipal**	**Small Pkg.**	**1989**	**1991**	
Big Sandy	15	252	147	195	78%
Little Sandy	3	70	97	51	81%
Tygarts Creek	1	13	0	0	-
Licking	18	144	118	113	53%
Kentucky	40	309	204	146	30%
Upper Cumberland	22	190	75	52	56%
Salt	24	263	322	248	59%
Green	38	165	100	667	36%
Tradewater	4	24	0	0	-
Lower Cumberland	15	41	60	25	100%**
Tennessee	9	62	0	0	-
Mississippi	12	19	32	24	100%
Ohio & Tributaries	57	384	60	58	71%
Total	**258**	**1,936**	**1,215**	**979**	

Source: Kentucky Division of Water, 305(b) Report, 1990-92

Worksheet #1 continued

Impact Seen in Every River Basin

Discharges from wastewater treatment plants are impacting 10 of the state's major river basins as can be seen in Figure 1. The pollutants most commonly associated with improperly treated sewage include fecal coliform bacteria, ammonia-nitrogen, dissolved oxygen, and total suspended solids. All these pollutants impact water quality and our ability to use our water resources for swimming, fishing, and as drinking water supplies.

The 1,936 smaller sewage treatment plants, known as "package plants," cause the greatest pollution problems due to their small size and the fact that many are not properly operated or maintained. These plants are commonly used for schools, subdivisions, and other facilities that are not connected to a major municipal system.

Septic Tanks Impacting Many Private Water Wells

Another way sewage is treated is through the use of septic tanks. More than half a million septic tanks are being used throughout Kentucky in areas where hook-up to municipal wastewater treatment plants is not available. Septic tanks are installed underground and typically can treat sewage from one home. However, septic tanks, like larger sewage treatment plants, must be properly installed and maintained to be effective. The Kentucky Department for Health Services estimates that at least half of the state's 207,000 private drinking water wells may be contaminated by bacteria due to malfunctioning septic tanks.

Improperly designed, installed, and maintained septic tanks are the most frequently reported source of bacterial pollution to groundwater in Kentucky. Many of these systems were installed prior to 1985, without regard to the protection of underground sources of water. Septic tanks are potentially polluting sources of groundwater in Logan, Jefferson, Warren, Edmonson, Hart, Barren, Grayson, Rowan, Montgomery, Bath, Menifee, and Morgan counties.

Straight Pipes Discharge Directly into Streams and Creeks

Some homeowners have neither installed septic tanks or hooked up to sewage treatment plants. Instead they discharge their wastes directly into streams and creeks, fouling the water. While laws requiring homes be connected to sewer systems or to install septic tanks have been on the books for many years, state and local government officials indicate they do not have enough resources and staff to ensure homeowners are complying with the law and the court system has been reluctant to crack down on violators.

A recent survey in Letcher County uncovered 700 pipes discharging sewage and other wastewater from homes directly into creeks. These discharges combined with pollutants released by poorly operated wastewater treatment plants are responsible for water pollution problems in the North Fork of the Kentucky River. The level of pollution has been so bad that for the last three years swimming has been banned by state health and environmental officials. A task force is looking into the problem and ways to solve it.

Questions?

1. To which river basin is your sewage discharged?
2. Is sewage a problem in your basin? Is it getting better or worse? Suggest reasons why.
3. Describe how sewage pollution might affect you.

What You Can Do...

1. Read the label. Buy the product with the least amount of toxic materials and avoid phosphate detergents.
2. Maintain your septic tank - if a septic system fails, untreated sewage and other waste can seep through the ground into your streams and groundwater. It is important to have your system properly maintained.
3. Report all water pollution incidents to the Kentucky Environmental Response Team at 1-800-928-2380.

Activity 4 Understanding Groundwater

Instruction Sheet

DO YOU KNOW...

- What percent of Kentuckians rely upon private water wells for their drinking water?
- Why the geology of many areas in Kentucky makes our groundwater very vulnerable to pollution?
- What are the major threats to the state's groundwater resources?

Groundwater an Important Resource in Kentucky

The residents of Dayhoit, Kentucky have learned about polluted water the hard way - they drank it, unknowingly for years. More than 200 residents drank well water contaminated by an industrial facility that illegally dumped chemicals in their community. Soil in the area is also suspected to be contaminated with a variety of chemicals, many of which are harmful to humans. The residents fear the nearby Cumberland River, which many use for swimming and fishing, is also contaminated. The people of Dayhoit have been involved in a long struggle to determine the extent of the pollution in their community and ensure it is properly cleaned up. They not only fear exposure to dangerous chemicals, but also fear they are not being told the "whole story" by government officials. Their story is a sobering case of the problems caused by groundwater pollution, especially how difficult it is to clean up once it has been polluted.

Kentucky's underground sources of water, known as groundwater, are vital to our state for many reasons. Groundwater provides a source of drinking water for many Kentuckians, supports agricultural water needs, and is used widely by industries and businesses to produce products and services. Groundwater supplies 20% of the state's drinking water needs. However, we know relatively little about the quality of groundwater.

Groundwater lies below the surface of the earth, filling the pores and fractures of soil and rock. This water collects in underground systems called aquifers or hydrologic regions. Since most groundwater comes from surface water draining into sinkholes and sinking streams, it has potential to become contaminated by pollutants that are carried along with the surface water. Groundwater contamination is being detected with increasing frequency around the state.

Generally, the major threats to Kentucky's groundwater are underground storage tanks that are leaking gasoline or other contaminants, malfunctioning septic tanks, runoff from farmlands, old landfills, hazardous waste sites such as the one in Dayhoit, spills, and unplugged oil and gas wells. Although most instances of groundwater pollution are not as dramatic as Dayhoit experienced, it is a subject of intense public debate since Kentucky has no comprehensive standards to protect groundwater resources.

Purpose:

The following activity will help you develop a general understanding of Kentucky's groundwater and the major threats to this resource statewide and locally. You will analyze the most current information available regarding statewide trends and combine it with information about your local environment so you can prepare a local "status" report and strategy for protecting your groundwater resources. The purpose of this activity is to increase your awareness of the importance and vulnerability of your groundwater and to engage you in finding solutions to this real world problem.

Procedure

Part 1: Researching the Issues

1. Obtain a copy of Worksheet #1 from your teacher. Read the article and, as a class, discuss how the contamination occurred, the impact on the local community, how residents are dealing with the situation, and what is being done to solve the problems.
2. Divide into four groups, A-D. Examine groundwater pollution issues in Kentucky that are provided on Worksheets #2 (A-D). Obtain the appropriate Worksheet labeled for your group from your teacher.
4. Write a brief summary of the issues assigned to your group and suggest possible solutions to the problems identified.
5. Have a representative from each group give the class an overview of the issue you examined.

Instructions continued

Part II: Increasing Your Knowledge

1. Obtain a copy of Worksheet #3 from your teacher and discuss it in class. Compare the groundwater threats in your county to other counties and answer the questions on Worksheet #3.
2. Divide into the four groups again. Each group should conduct a more extensive investigation into groundwater, including a definition of "karst geology", how it can contribute to groundwater contamination problems, and how the hydrologic cycle works. Prepare a list of the land use activities in your community that might contribute to groundwater pollution (agriculture, open dumping, etc.). Consider and list things people might do at their homes such as pouring used oil or fuel onto the ground, school, or during other activities that could result in the pollution of groundwater.
3. As a class, review the list prepared by each group and develop a single list that incorporates the major groundwater pollution threats in your community.
4. Each student should now prepare a report that describes groundwater's role in nature and its importance in Kentucky. Include in the report the major threats to groundwater and what needs to be done to protect this resource.

Part III - Finding Solutions

1. As a class, prepare a survey to determine the opinions of schoolmates, friends, family, neighbors, farmers, and others regarding groundwater and the importance of its protection. Each student should interview at least three people. Compile the results and present them to the class.
2. As a class, review the survey findings and discuss strategies to reduce the threats to groundwater resources. Consider the following during the discussion:
    A. Who has responsibility, authority, and motivation to protect groundwater in your area.
    B. Imagine that you are a local official with the responsibility to address the groundwater problems in your community. Suggest strategies for getting the community together to prevent contamination of groundwater.
3. Write to your elected officials such as the county judge/executive, mayor, state legislator, and the Governor and ask them if your community or the state has a strategy to protect groundwater. Summarize in the letter the threats identified in your research as well as your survey findings.
4. Share the information you gathered by developing a school display, writing an article for the school newspaper, starting a school environmental newsletter, or writing an environmental column for your school newspaper.

Other Activities:

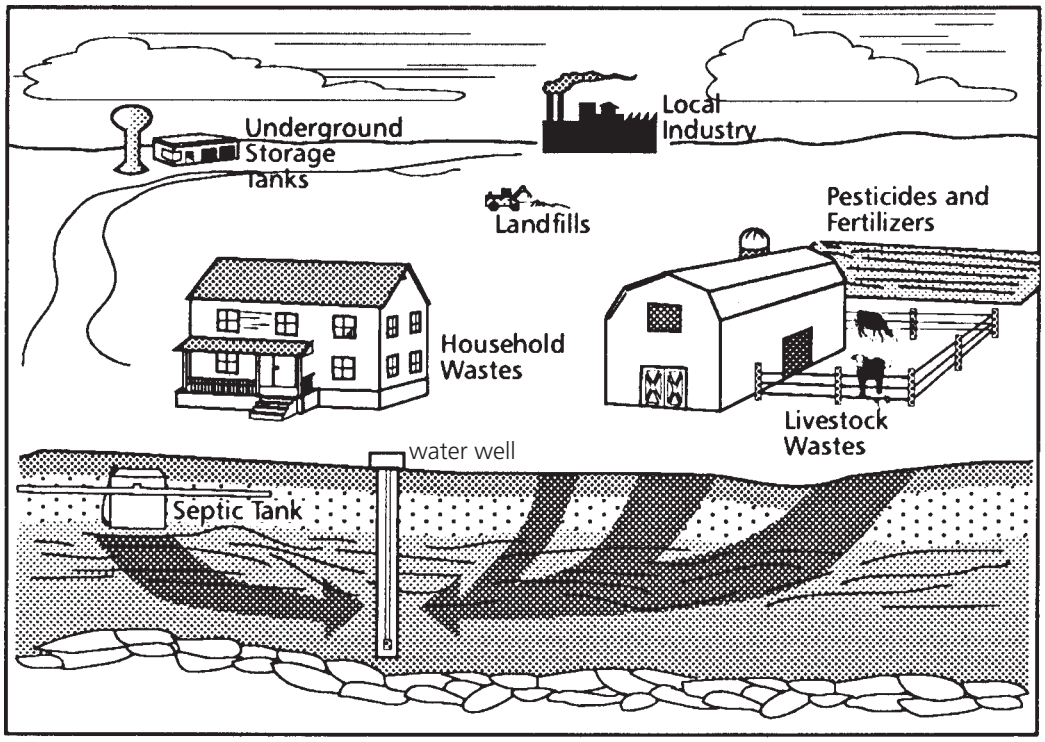
1. For those of you who have a water well, bring a jar of water to school (take the sample just before you leave home). Collaborate with the chemistry class to test the pH, bacteria, turbidity, hardness, and other parameters of the samples and compare the class results.
2. Water dowsing or water witching is the ancient folklore practice using various techniques to locate groundwater. The practice usually involves splitting a twig from a tree and walking over the ground until the twig bends or shakes. Water witching can be traced back thousands of years and people have often claimed successful results in locating water for a well. There is actually an American Society of Dowsers, Inc., in Danville, Vermont, 802-684-3417. Many interesting discussions can take place in the classroom regarding dowsing and the historical importance of locating homes close to a well or spring. Conduct a water dowsing experiment and compare it to how water is located today.
3. Invite a representative from the local health department to discuss the health concerns related to water well pollution problems in your area.

Instructions continued

References/Additional Resources:

1. The Kentucky Department for Health Services will provide information about testing private water wells. Contact the Department at 502-564-4856 or write them at 275 East Main St., Frankfort, KY 40602. Your local health department will also test water wells for bacteria and can be located in the telephone book under county offices.
2. If you suspect pesticides may be polluting your drinking water well, the Kentucky Division of Pesticides will test it. Call the division at 502-564-7274 or write to 500 Mero St. Frankfort, Ky. 40601 to request a test.

Groundwater Pollution Threats



Source: American Groundwater Trust - Reprinted with Permission

Activity 4. Understanding Groundwater

Worksheet #1

CONTAMINATED BY MISTRUST
Chemical cleanup brings Dayhoit uncertainty, not relief

by John Voskuhl, staff writer, Courier-Journal
April 18, 1993

DAYHOIT, KY. Beneath the ground lurk chemicals. Above the ground lurk doubts.

Those are the facts of life in Dayhoit, a Harlan County community of several hundred people where unchecked pollution from a nearby industrial plant has contaminated the soil and ground water.

Four years ago, more than a dozen wells in the area were found to be polluted with dangerous chemicals. Although a public waterline has since been extended to Dayhoit, the ground water cleanup remains incomplete, and there is disagreement over the extent of the problem.

In the meantime, residents, who for years drank water that they call "a chemical soup" with ingredients linked to cancer, say they no longer trust the people charged with cleaning up the contamination.

"I'm terrified. I'm terrified ever day," said 36-year-old Teri Blanton Howard, a lifelong Dayhoit resident who had a hysterectomy at 30 to remove cancerous tissue and who saw her mother die last year of cancer. "I wish I could just say, 'OK, they're going to clean this up.' But I just can't feel that way."

There is no hard medical evidence that Dayhoit's contamination has caused any health problems, though an estimated 200 people drank polluted well water. But that uncertainty only fuels mistrust, residents say.

For officials with the federal Environmental Protection Agency (EPA), which has placed the plant on its Superfund list and is overseeing its cleanup, the mistrust fuels frustration.

"Technically, this is not a very complicated site," said Derek Matory, the EPA's remedial project manager. "The mistrust in the community is what has taken up all my time. It's very taxing."

In January, EPA officials decided to stop holding public meetings on the cleanup, citing threats from residents. In addition, residents reportedly have threatened to dynamite a device that will be used to clean the ground water. The device, called an air stripper, has drawn criticism from residents who contend it will only compound pollution problems.

For Cooper Industries, the Houston-based corporation that has accepted responsibility for the cleanup, the criticism and mistrust seem unfair, said John Breed, a company spokesman. "Cooper didn't pick this - as I'm sure the residents didn't pick it either," he said. "But this is what we have."

Dayhoit's pattern of pollution may have begun when McGraw-Edison Corporation opened the National Electric Coil plant in the 1950s. The plant used solvents to clean electric motors, and former employees such as Garnett Howard (no relation to Teri Howard) remember seeing wheelbarrows full of solvent-laced "muck" dumped on the banks of the Cumberland River.

Cooper Industries bought McGraw-Edison in 1985 and sold the National Electric Coil plant to a local firm, Treen Land Co., in 1987. After the contamination was found in 1989, the EPA named Cooper a "potentially responsible party," and company officials decided to take responsibility for the cleanup.

So far Cooper has paid to install the new waterlines in the area, to assess the environmental damage and to remove contaminated soil from the plant site. Cooper also will pay for the ground water cleaning process, which could begin later this month. Breed said Cooper has spent about $5 million on the site.

Among residents, however, Cooper has bought little goodwill.

Joan Robinett, a former Dayhoit resident who heads a local citizens group, and others believe the EPA has not required Cooper to determine the full extent of the contamination. Though additional soil testing is under way, residents fear the EPA will

Worksheet #1 continued

someday pronounce the problem solved, leaving undetected toxic time bombs ticking away beneath their feet.

"This is our fear: Cooper will pack their bags up," Robinett said. "And EPA will pack their bags up. And the area will still be contaminated."

But the EPA's Matory said officials know the extent of the pollution. First, he said, soil on the plant site was contaminated with dangerous amounts of polychlorinated biphenyls, or PCBs. And second, a family of chemicals called volatile organic compounds has seeped into the groundwater in a "plume" that stretches about three-fourths of a mile southwest from the plant.

In terms of human health, Matory said, the contamination poses no problem now. The PCBs have been removed, and the people whose well water was contaminated have waterlines, he said.

"It's highly unlikely that anything's going to sneak through the cracks that would be a health concern," Matory said, adding: "There are people in the community who - for whatever reason - don't want to acknowledge that. It's unusual."

But people like Donna Barton, whose family has lived since 1981 at the Holiday Mobile Home Park, where the well-water contamination was first discovered, laugh derisively at the EPA findings that the PCB problem stopped at the plant's property line.

"We call it the magic fence," she said.

Health is always on the minds of Dayhoit residents. The federal Agency for Toxic Substances and Disease Registry compiled a list of 105 health complaints among the area's 350 or so residents. They ranged from nosebleeds to blurred vision to sterility.

But Dr. Ralph Magnotti Jr., a physician at the University of Cincinnati, conducted health screenings in Dayhoit and said he found no conditions that appeared to be related to toxic exposure.

Still, the residents' greatest concern is cancer.

"Every family in Dayhoit has been touched by cancer," said Garnett Howard, who lost a son, William, to Hodgkin's disease in 1986 and then another son, David, diagnosed with the disease a year later. David Howard is now in remission.

Dr. Arthur Frank, a physician at the University of Kentucky who conducted health screenings in Dayhoit in 1989, said it's nearly impossible to study cancer incidence in a meaningful way there.

In small populations, Frank said, even one case of cancer becomes statistically disproportionate. "You are basically guaranteeing an inconclusive study," he said.

But there is no doubt in the mind of Ruth Howard, Garnett Howard's wife, about what killed her son.

During a recent interview she tried to explain her anger toward government officials.

"If you took a big, beautiful boy who was 6-foot-3 and watched him waste away to nothing," she said, her sentence trailing off as tears began to fall.

"I'd almost guarantee you that if one of those people had lost a child to cancer, they'd be a lot more sympathetic."

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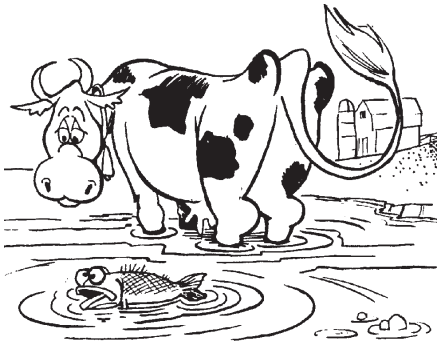
Activity 4. Understanding Groundwater
Worksheet #2



Group A: Issue Paper

Groundwater Impacts from Farming, Bacteria, Toxics, and Hazardous Materials

Very little information has been collected in Kentucky regarding the quality of groundwater resources, even though it supplies 20% of the state's drinking water needs. During the past few years, instances of groundwater contamination have been detected with increased frequency across the state. While specific information is not available to determine whether overall groundwater quality is improving or declining, the detection of contamination in a number of private water wells and several community public water systems supplied by groundwater indicates that quality is being threatened statewide. Despite its importance, Kentucky has no comprehensive groundwater protection standards.

Groundwater resources are particularly vulnerable to contamination from many pollution sources due to the state's complex and highly varied geology. Almost 50% of Kentucky's geology is comprised of karst, a land surface characterized by sinkholes, sinking streams, and an interconnected underground network of caves. Since most groundwater comes from surface water entering through sinkholes and sinking streams, it has a high potential to become contaminated by pollutants carried along with the surface water.

Bacteria From Human and Animal Waste a Major Threat

A number of Kentuckians rely on private wells supplied by groundwater for drinking. Testing of water wells has revealed a variety of contamination problems. For example, a 1988 study of 111 wells in Bath, Montgomery, Rowan, Morgan, and Menifee counties detected bacterial contamination in 90% of the hand-dug wells and 33% of the machine drilled wells. Bacterial contamination is primarily associated with sewage from humans and animals. Tests of another 1,761 water wells found that 50% were contaminated by bacteria.

Studies have also revealed that, of the 468 cisterns tested, 27% were contaminated with bacteria. (Cisterns are holding tanks used for drinking water supplies.) And 43% of 231 underground springs sampled had unsafe levels of bacteria. The Kentucky Department for Health Services estimates at least half the wells may have bacterial contamination problems, primarily due to poor water well construction that allows pollution to seep into the well.

The Kentucky Department for Health Services will test water wells for bacterial contamination when citizens request it. Water well drillers are now required to be trained and certified to ensure wells are drilled properly. Operators must disinfect newly drilled wells to kill harmful bacteria and test wells to be sure that the water is safe for use.

Farm Chemicals Pose Risks to Groundwater

Chemicals used for farming, including fertilizers and pesticides, also pose risks to groundwater in Kentucky. These chemicals can run off farmland after it rains and contaminate well water.

In 1989, 888 private water wells were tested for agricultural chemicals. The tests revealed various levels of nitrates in all the wells; 6% had concentrations exceeding health standards. Nitrates, found in fertilizers, animal wastes, and other products, can cause stomach cancer and a rare, but critical, infant disease known as methemoglobinemia if ingested at certain levels.

Pesticides used in the production of crops and for lawn care are also a threat to private well water supplies and are commonly detected when water wells are tested. Thirty-one percent of 200 wells tested during 1989 in Christian, Todd, Hickman, and Henderson counties had detectable levels of triazines, a common class of herbicides used on Kentucky farmlands, although most levels detected did not exceed the national and state drinking water standards.

Worksheet #2 continued

Group A continued...

Toxic Chemicals Detected in Water Wells

Toxic materials such as arsenic, industrial solvents, and radioactive contamination have been detected in water wells in some areas of the state. In 1991, four wells were discovered with high levels of arsenic at Katherine Station in Bullitt County. The source of this pollution has not been determined. Eleven wells in Logan County near Keysburg were discovered to be contaminated with trichloroethylene, a common chemical used for dry-cleaning and industrial purposes. The source was an old landfill which closed in 1979. The state provided affected residences with alternative water supplies and required the site to be cleaned up.

Many other water wells may be contaminated with toxic chemicals, however there is no comprehensive testing or monitoring program in place to determine the quality of drinking water from private wells and other self-supplied sources including cisterns and springs.

Some Programs Established to Protect Water Well Supplies

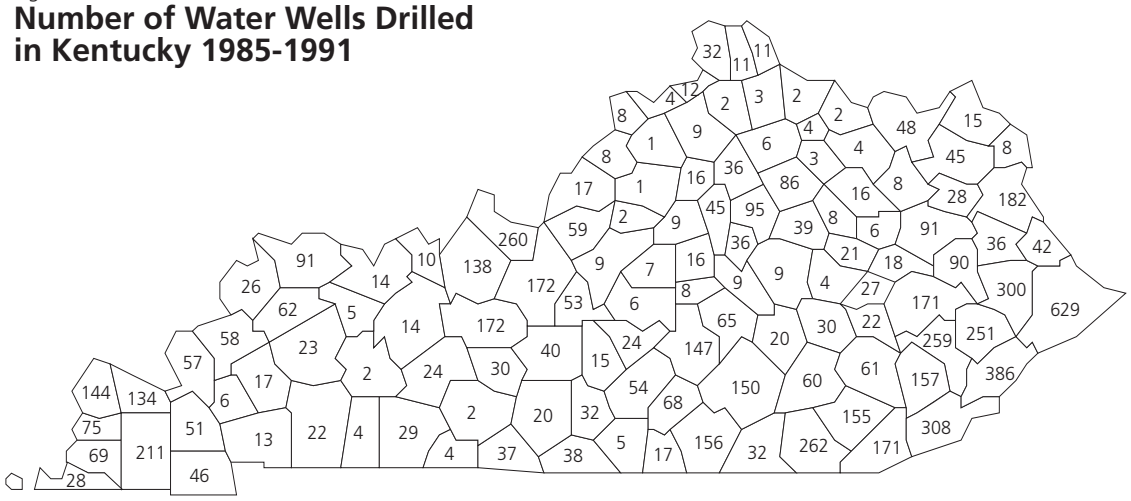
Water wells are used in every county of the Commonwealth for drinking water. Between 1985 and 1992, 14,520 drinking water wells were reported drilled in the state. The greatest number of wells was drilled in Pike County (629), followed by Letcher (386), Harlan (308), Floyd (300), Whitley (262), Perry (259), and Graves (211) counties (Figure 1).

Some programs have been established to protect water well supplies. Since 1985, state regulations have required all water well drillers to be certified to ensure the proper construction of water wells. A few local groundwater protection programs have also been initiated. For example, Owensboro, Worthington, and Calvert City are in the process of developing programs to protect groundwater by controlling activities that cause pollution in vulnerable areas.

But much more needs to be done to protect groundwater in Kentucky. The state needs to move forward and establish groundwater protection programs to preserve our groundwater both now and for future generations.

Figure 1

Number of Water Wells Drilled in Kentucky 1985-1991



Source: Kentucky Division of Water, 1991

Worksheet #2 continued

Group B: Issue Paper

Groundwater Impacts from Coal Mining, Oil and Gas Drilling, Discharges to Sinkholes

Very little information has been collected in Kentucky regarding the quality of groundwater resources, even though it supplies 20% of the state's drinking water needs. During the past few years, instances of groundwater contamination have been detected with increased frequency across the state. While specific information is not available to determine whether overall groundwater quality is improving or declining, the detection of contamination in a number of private water wells and several community public water systems supplied by groundwater indicates that quality is being threatened statewide. Despite its importance, Kentucky has no comprehensive groundwater protection standards.

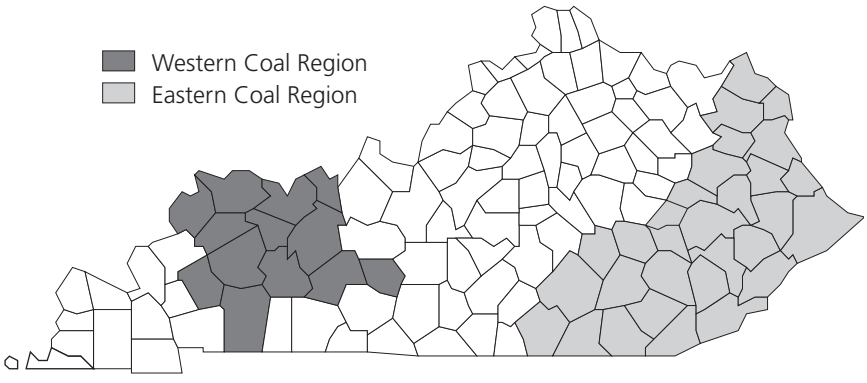
Groundwater resources are particularly vulnerable to contamination due to the state's complex and highly varied geology. Almost 50% of Kentucky's geology is comprised of karst, a land surface characterized by sinkholes, sinking streams, and an interconnected underground network of caves. Since most groundwater comes from surface water entering through sinkholes and sinking streams, it has a high potential to become contaminated by pollutants carried along with the surface water.

Coal Mining Affects Groundwater in Several Areas

Coal is an important economic and energy resource in Kentucky (Figure 2). But coal mining also impacts the environment. Polluted runoff from 90,000 acres of abandoned mine lands have affected ground and surface water in several areas of the state, especially in Eastern Kentucky. Blasting at many of the 3,000 active coal mines in Kentucky can also disrupt water supplies. During 1990, nearly 1,500 citizens in Kentucky registered complaints with the state regarding coal mining. Many alleged that blasting from underground mining damaged their water well supplies. Citizens have been lobbying the state legislature and Congress to protect their drinking water wells from adverse coal mining impacts and to require mining operators to replace or repair damaged water supplies.

The Kentucky Division of Abandoned Mine Lands (DAML) has received a number of requests from local governments for assistance in developing public water supplies where private water wells have been impacted by past mining practices. DAML is in charge of distributing federal abandoned land funds to address past mining abuses. The fund is financed from a surcharge on coal mined in the state. DAML has reviewed groundwater problems caused by abandoned mine lands in a number of areas and has provided funds for water lines in 20 communities, most of which were in Eastern Kentucky.

Figure 2
Major Coal Producing Counties



Source: Kentucky Department for Surface Mining Reclamation and Enforcement, 1991

Worksheet #2 continued

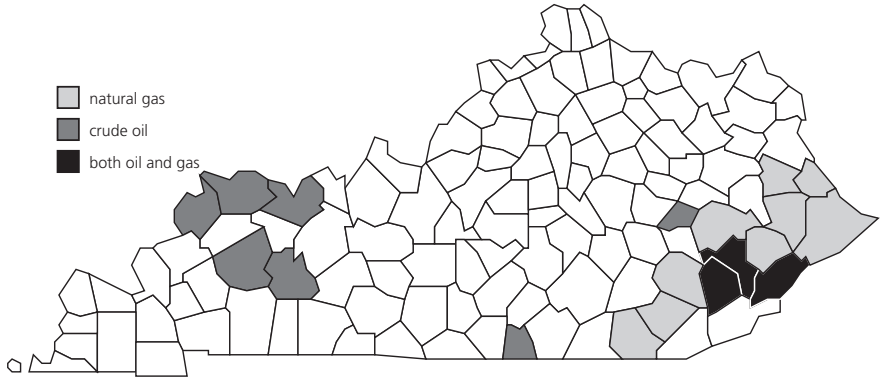
Group B continued...

Oil and Gas Drilling Impacts to Groundwater

There are 30,000 oil and gas production wells operating in Kentucky (Figure 3). Salty brine water extracted during the drilling process is a threat to both surface and groundwater if not properly managed and disposed. There are also an estimated 60,000 abandoned unplugged oil and gas wells in the state providing direct routes for contaminants to pollute the groundwater. This may be a conservative estimate since thousands of wells were drilled prior to any official record-keeping. Since 1986, only 164 of these abandoned wells have been plugged.

Some industrial wastes and oil brines are injected underground into wells normally drilled 600 to 2,500 feet deep. This is known as "underground injection." Improper injection of wastes also poses risks to groundwater. There are more than 500 oil brine injection wells permitted in Kentucky and two hazardous waste injection wells operated by DuPont Chemical in Louisville. DuPont is permitted by the Kentucky Department of Environmental Protection to inject 70 million pounds of dryweight hydrochloric acid a year until the year 2000. During 1989, the company injected 39 million pounds of acid, but reduced that amount to 9.4 million pounds in 1990 by recycling some of the waste. Injection wells are considered a safe way to dispose of some wastes. However, the federal government is phasing out the use of hazardous waste injection wells like the one used by Dupont because of the risk these pollutants pose to groundwater.

Figure 3
Leading Oil and Gas Producing Counties in Kentucky



Source: Kentucky Department of Revenue, 1991

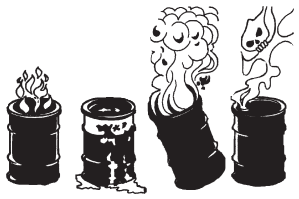
Sinkholes Provide Direct Pathway for Contamination

Sinkholes, a natural depression in the land surface common throughout Kentucky usually due to the collapse of a cave or cavern underneath it, are direct routes to groundwater systems and a primary way through which pollution enters. Some industries and sewage treatment plants are allowed by the state to discharge treated wastewater into sinkholes when surface waters, such as streams or rivers, are not available, primarily in Western Kentucky. Currently, 40 facilities including industries, schools, small sewage treatment plants, and oil wells are permitted to discharge wastewater containing various pollutants directly into sinkholes. The degree to which these discharges impact groundwater is generally unknown since groundwater monitoring is not required. Some counties have adopted ordinances banning the disposal of materials in sinkholes to protect local water supplies.

Groundwater Protection Efforts Needed

Kentucky has neglected its groundwater resources for too long. The loss of private water wells from pollution and other activities has had major impacts, particularly on rural areas of the state that depend on groundwater as a primary drinking water source. Kentucky should move forward and establish programs to protect its groundwater resources.

Worksheet #2 continued



Group C: Issue Paper

Groundwater Impacts From Landfills, Open Dumps, and Hazardous Waste Sites

Very little information has been collected in Kentucky regarding the quality of groundwater resources, even though it supplies 20% of the state's drinking water needs. During the past few years, instances of groundwater contamination have been detected with increased frequency across the state. While specific information is not available to determine whether overall groundwater quality is improving or declining, the detection of contamination in a number of private water wells and several community public water systems supplied by groundwater indicates that quality is being threatened statewide. Despite its importance, Kentucky has no comprehensive groundwater protection standards.

Groundwater resources are particularly vulnerable to contamination due to the state's complex and highly varied geology. Almost 50% of Kentucky's geology is comprised of karst, a land surface characterized by sinkholes, sinking streams, and an interconnected underground network of caves. Since most groundwater comes from surface water entering through sinkholes and sinking streams, it has a high potential to become contaminated by pollutants carried along with the surface water.

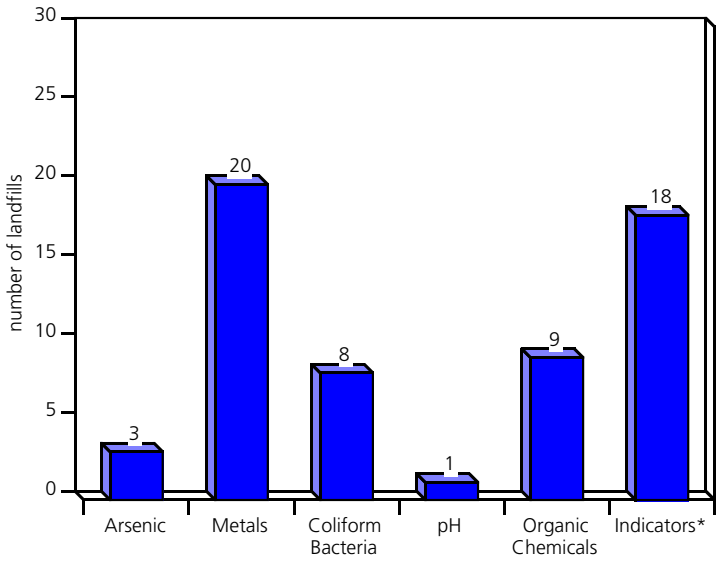
Many Old Landfills Polluting Groundwater

The disposal of hazardous, solid, and toxic wastes is increasingly impacting the quality of the state's groundwater. The Kentucky Division of Waste Management (DWM) has identified 626 old solid waste landfills potentially leaking contamination into the groundwater.

Concern about groundwater pollution from leaking garbage landfills led the state to pass more stringent solid waste laws in 1991 (Figure 4). Forty-one of the state's 75 landfills that did not meet the new requirements

Figure 4

Type of Contamination Detected at Solid Waste Landfills with Groundwater Monitoring (1991)



**Includes pH, iron, sodium, total organic carbon, total dissolved solids, total organic halides.*

Source: Kentucky Division of Waste Management, 1991

Worksheet #2 continued

Group C continued...

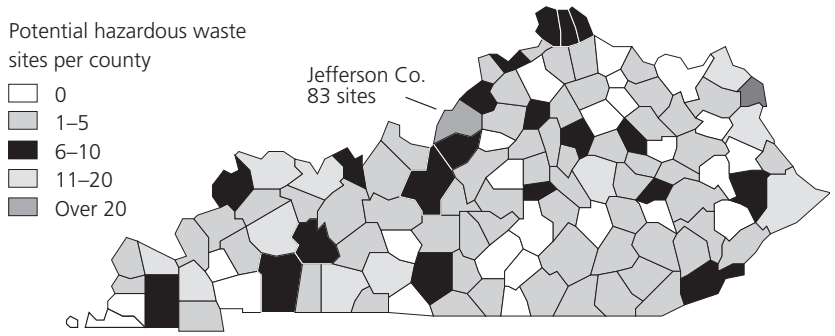
to prevent groundwater pollution, were ordered to close by June 1992. The 30 remaining solid waste landfills, which will be allowed to operate until 1995, must now monitor groundwater and address pollution problems if detected. New landfills will have to be constructed with two liners that ensure wastes are contained within the landfill and do not contaminate groundwater.

Hazardous Waste Sites Pose Significant Threats to Groundwater

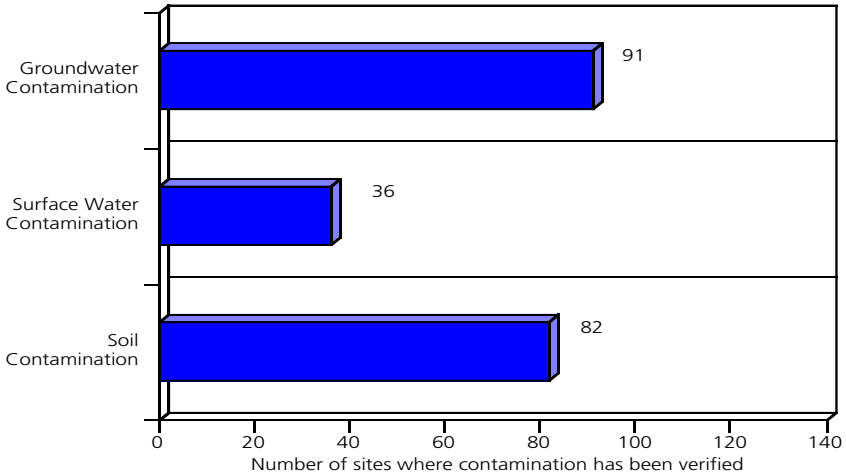
More than 536 potential hazardous waste sites are also impacting Kentucky's groundwater. And the number grows yearly by 40 to 50 sites. Some of these sites were old solid waste landfills and others were illegal dumps. Of the 254 waste sites investigated, contamination has been verified at 181 (Figure 5). Some sites pose such a great risk they have been classified as federal Superfund sites. Groundwater contamination has also been verified at 16 of the 19 federal Superfund sites located in Kentucky. These Superfund sites are being investigated and cleaned up by the federal government due to the pollution threats to people living around the site.

Figure 5

Hazardous Waste Sites (Potential) in Kentucky



Contamination Detected at Hazardous Waste Sites



Source: Kentucky Division of Waste Management, 1991

Worksheet #2 continued

≈ Group D: Issue Paper ≈

Groundwater Impacts From Leaking Underground Tanks, Poor Well Construction, and Septic Tanks

Very little information has been collected in Kentucky regarding the quality of groundwater resources, even though it supplies 20% of the state's drinking water needs. During the past few years, instances of groundwater contamination have been detected with increased frequency across the state. While specific information is not available to determine whether overall groundwater quality is improving or declining, the detection of contamination in a number of private water wells and several community public water systems supplied by groundwater indicates that quality is being threatened statewide. Despite its importance, Kentucky has no comprehensive groundwater protection standards.

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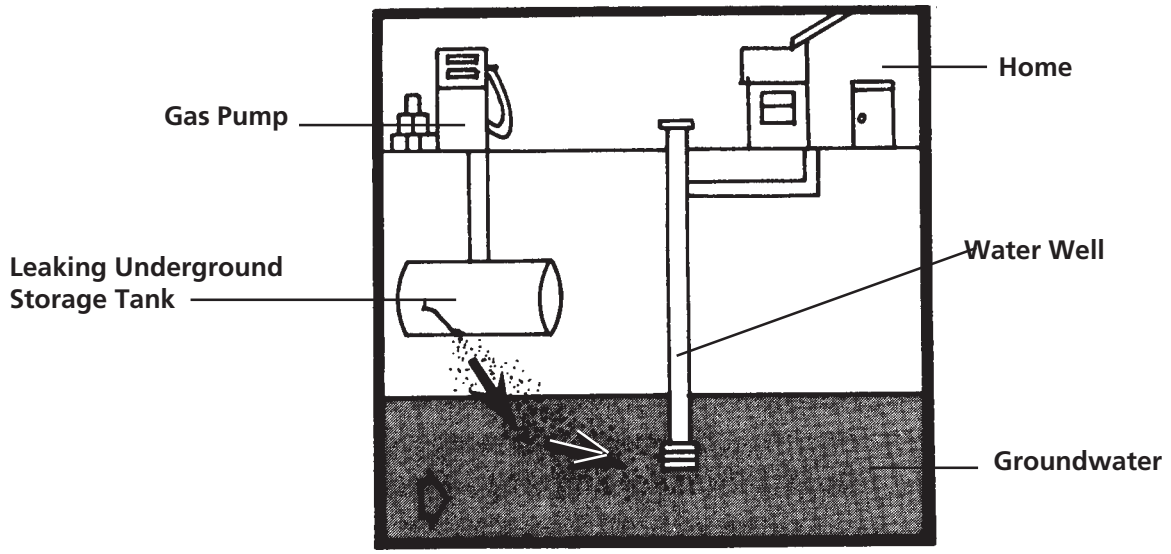
Leaking Underground Tanks Among the Greatest Groundwater Threats

One of the greatest threats to groundwater resources is leaking underground storage tanks. More than 34,000 underground tanks containing materials such as gas, oil, hazardous materials, and diesel fuel are buried throughout the state. The U.S. Environmental Protection Agency, the federal agency that carries out environmental laws passed by Congress, estimates that at least 25% of the tanks may be leaking contaminants into the ground.

These contaminants move quickly into groundwater and pollute sources of drinking water. For example, the City of Georgetown detected benzene, a major constituent of gasoline, in its public drinking water supply. The city has been unable to identify the source of contamination in Royal Spring, its primary source of drinking water, although leaking underground gas tanks are suspected. Permanent activated charcoal filters and air strippers have been installed to treat Georgetown's water.

Leaking Underground Storage Tank



Reprinted with Permission-American Groundwater Trust

Worksheet #2 continued

Group D continued...

State efforts to identify leaking underground petroleum storage tanks has been ongoing since 1988. As of December 1991, 1,175 underground tanks had been replaced and approximately 883 soil cleanups from leaking tanks had been conducted across the state. You may have noticed cleanups of leaking tanks at gas stations in your community.

Private Wells Often Contaminated by Bacteria From Septic Tanks

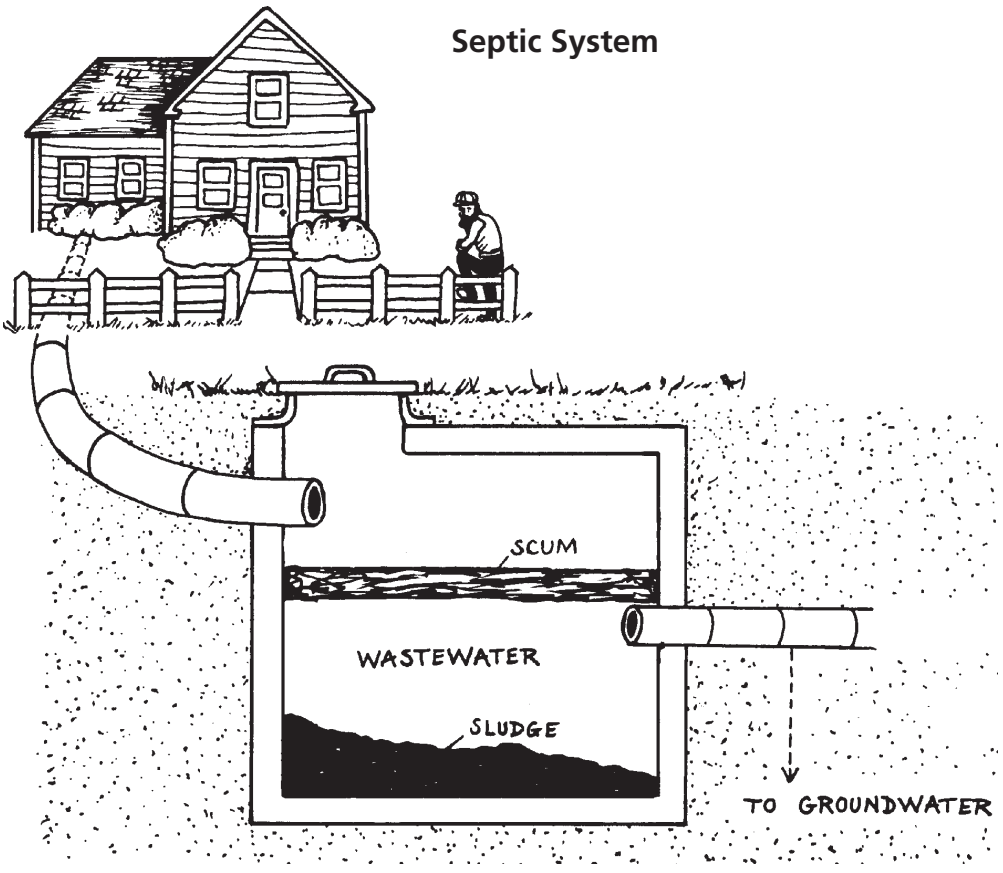
Septic tanks are another source of groundwater pollution in Kentucky. The Kentucky Department for Health Services estimates that at least half of the state's 207,000 private water wells may be contaminated by bacteria due to malfunctioning septic tanks.

Improperly designed, installed, and maintained septic tanks are the most frequently reported source of bacterial pollution to groundwater in Kentucky. There are half a million septic tanks in use in Kentucky. Many of these systems were installed prior to 1985, without regard to groundwater protection, and under conditions now prohibited. On-site sewage disposal systems are potentially impacting sources of groundwater in Logan, Jefferson, Warren, Edmonson, Hart, Barren, Grayson, Rowan, Montgomery, Bath, Menifee, and Morgan counties, and probably others.

The Kentucky Department for Health Services is promoting the use of man-made artificial wetlands for sewage treatment to reduce the problems of failing septic tanks. These artificial wetlands treat sewage by filtering it through vegetation, such as cattails, which use the excess nutrients and other organic matter that cause pollution problems. About 125 artificial wetland systems have been constructed in Kentucky, primarily to treat the sewage from single family homes. The state is currently monitoring the ability of these systems to treat sewage adequately.

Pollution threats from septic tanks can be reduced if the systems are properly installed and operated. It is also important that private water wells are drilled, disinfected, and properly maintained to prevent contamination.

Septic System



Source: University of Kentucky, "Water Wise."

Activity 4. Understanding Groundwater

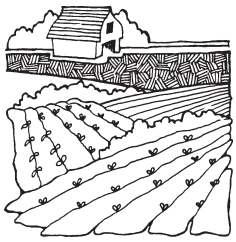
Worksheet #3

Threats to Groundwater Numerous

Instances of groundwater contamination are being detected more frequently across the state (Figure 1). Contamination is caused by many sources including thousands of leaking underground storage tanks, landfills, hazardous waste sites, and septic tanks (Figure 2).

Efforts to protect groundwater quality in Kentucky have been limited and clean up of contamination has been difficult. State programs have primarily focused on ensuring the proper construction of water wells to minimize pollution problems and requiring certain facilities to monitor groundwater quality.

In 1993, the Kentucky Department for Environmental Protection formed a group composed of representatives from the farming, business, environmental, and public interests to help develop a strategy to protect Kentucky's groundwater resources. The group recommended that groundwater protection plans be prepared for certain contamination sources such as oil and gas wells, agriculture production, and manufacturing plants, to prevent future contamination.



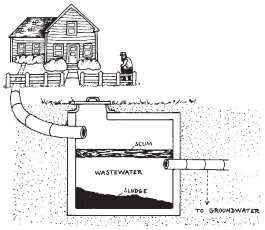
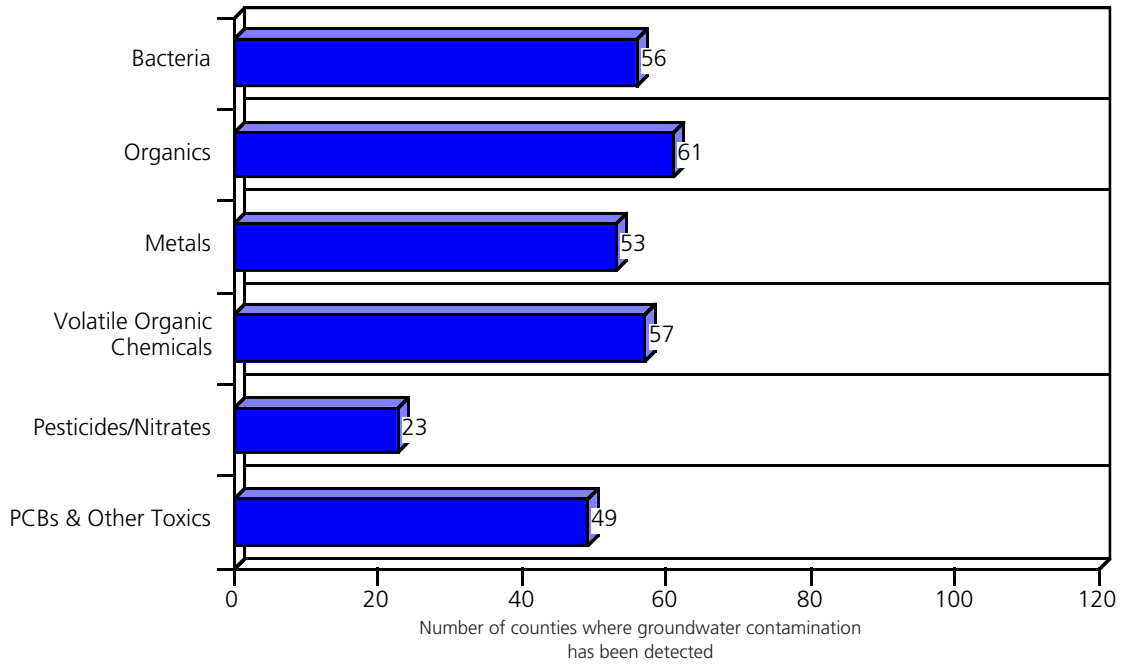


Figure 1

Known Instances of Groundwater Contamination in Kentucky



Source: Kentucky Division of Waste Management; Kentucky Division of Water; University of Kentucky Water Well Surveys, 1990–1991

Worksheet #3 continued

Figure 2

Threats to Kentucky's Groundwater

(number per county)

County	Old Landfills*	Septic Tanks**	Unplugged Wells	Underground Storage Tanks	Potential Hazardous Waste Sites	Underground Injection Wells ***
Adair	5	3,269	875	220		220
Allen	3	3,222	933	143		143
Anderson	2	1,922	3	143	4	
Ballard	6	2,036	8	116	2	
Barren	1	6,311	1,692	559	6	5
Bath	1	2,171	126	81	1	
Bell	3	4,876	403	256	4	1
Boone	5	6,353	4	529	9	
Bourbon	5	2,946	12	168		
Boyd	10	7,320	755	474	16	2
Boyle	9	2,456	8	299	7	
Bracken	4	1,294	5	120		
Breathitt	3	2,600	1,705	171		
Breckinridge	16	3,960	986	222	1	
Bullitt	5	7,164	54	310	7	
Butler		2,343	1,063	147	1	4
Caldwell	4	2,394	408	155	3	
Calloway	3	5,442	17	287	5	
Campbell	9	4,482	3	454	8	
Carlisle	2	1,306	7	53	2	
Carroll	7	1,366	20	142	9	
Carter	3	5,404	440	274	3	
Casey	3	3,392	1,036	162		
Christian	10	5,429	1,672	1,585	7	8
Clark	5	2,818	29	264	5	
Clay	7	4,075	3,030	164	4	
Clinton	1	2,552	1,912	140		7
Crittenden	2	1,965	231	105	1	
Cumberland	3	1,437	2,504	125	1	7
Daviess	6	8,248	8,117	863	20	20
Edmonson	3	2,710	463	91		1
Elliott	1	1,449	1,463	59	12	
Estill		2,257	1,505	163	1	4
Fayette	7	10,829	2,643	383	8	
Fleming	5	2,355	28	187	2	
Floyd	13	10,829	2,643	383	8	
Franklin	7	4,026	10	420	6	
Fulton	18	865	13	108		
Gallatin	1	1,006	26	76	1	
Garrard	6	2,083	111	131	1	
Grant	7	2,603	90	181	1	
Graves	7	7,570	30	278	8	
Grayson	3	4,915	900	315	1	
Green	3	2,484	1,047	138	2	25
Greenup	9	5,633	105	287	12	3
Hancock	6	1,217	988	85	7	13
Hardin	7	9,914	444	989	15	
Harlan	9	7992	25	361	7	
Harrison	2	2,360	8	181	3	
Hart	3	3,345	1,089	296	4	8
Henderson	7	4,884	13,072	446	13	85
Henry	4	2,783	34	217	2	
Hickman	3	1,438	6	27		
Hopkins	9	6,795	6,120	499	20	40
Jackson	2	2,575	386	127	2	
Jefferson	28	41,504	56	5,272	87	4
Jessamine	2	3,381	8	205	4	
Johnson	5	5,019	2,620	198		3
Kenton	6	6,763	7	696	9	
Knott	6	4,121	2,350	121		
Knox	5	6,258	1,064	261	2	
Larue	1	2,925	139	100	1	
Laurel	2	9,586	325	528	4	
Lawrence	3	3,005	1,896	132	3	9
Lee	3	1541	2,155	99	9	74
Leslie	4	3,120	2,732	101	1	1
Letcher	6	6,375	2,118	231	1	
Lewis	5	2,984	61	09		
Lincoln	4	4,285	241	204	1	
Livingston	2	2,763	6	120	1	
Logan	6	4,263	540	256	12	
Lyon	1	1,421	2	82		
Madison	6	6,965	57	491	13	
Magoffin	20	3,605	1,822	91		37
Marion	3	2,446	66	143	2	
Marshall	9	6,190	9	407	16	
Martin	1	2,501	1,307	83	3	1
Mason	6	2,657	4	191	1	
McCracken	13	6,836	30	619	15	
McCreary	6	3,394	239	130	1	
McLean	6	2,336	6,640	96	3	19
Meade	8	3,647	273	208	3	1
Menifee	1	1,201	294	75		
Mercer	7	3,532	9	193	5	
Metcalfe	12	2,189	1,236	123	1	3
Monroe	1	3,089	784	91	1	4
Montgomery	5	3,255	24	212	6	
Morgan	3	2,610	126	129	1	
Muhlenberg	11	6,822	6,951	323	6	20
Nelson	3	4,904	54	371	3	
Nicholas	3	1,071	6	80		
Ohio	3	4,796	3,327	292	3	19
Oldham	2	4,891	19	245	10	
Owen	12	1,780	20	63		
Owsley	1	1,123	170	56		
Pendleton	2	1,750	9	144	1	
Perry	7	5,780	2,690	597	3	
Pike	13	20,831	4,225	622	12	2
Powell	3	1,862	360	114	1	2
Pulaski	7	11,261	567	633	5	
Robertson	2	506	8	26		
Rockcastle	3	2,511	51	140		
Rowan	7	3,090	345	152	3	
Russell	5	3,654	735	165		
Scott	6	2,880	17	222	1	
Shelby	2	5,300	10	288	1	
Simpson	2	2,235	219	298	1	2
Spencer	2	1,438	10	95		
Taylor	2	3,614	124	217	1	
Todd	1	2,838	628	134	2	2
Trigg	3	2,520	27	158		
Trimble	1	1,964	1	65	1	
Union	4	2,029	5,726	196	6	18
Warren	6	10,502	2,726	910	12	
Washington	2	1,658	18	96		28
Wayne	3	3,100	639	190	2	
Webster	7	2,969	5,215	127	5	22
Whitley	10	5,815	483	306	5	
Wolfe	5	1,414	963	90	1	31
Woodford	3	2,449	6	177	5	
Total	**626**	**510,637**	**124,280**	**34,655**	**552**	**575**

* Also includes old landfarming operations
**1980 Kentucky Census Data for septic tanks
*** used for brine disposal, 2 wells in Jefferson County used for hazardous waste disposal

Source: Kentucky Division of Waste Management; Kentucky Division of Water; Kentucky Department of Health; Kentucky Department of Mines and Minerals; U.S. EPA, 1991

Worksheet #3 continued

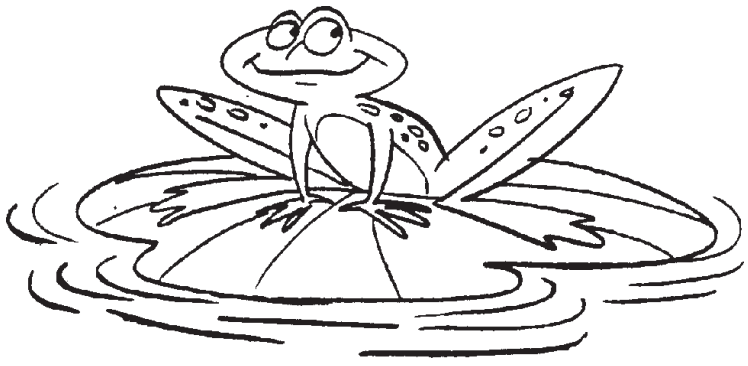
Local governments can also take action to protect groundwater by protecting areas where surface water enters the groundwater. These areas are called groundwater recharge areas. Only a few communities in Kentucky are in the process of establishing programs to protect their groundwater recharge areas.

Questions?

1. Write a paragraph that suggests how you may contribute to groundwater pollution.
2. What possible reasons could explain the difference in the number of groundwater threats among counties shown in Figure 2, Worksheet #3?
3. Which county in Figure 2, Worksheet #3 appears to have the greatest overall threats to groundwater? Why do you think this is so?
4. Based on information in Figure 2, Worksheet #3, which county do you think is the safest place to drink groundwater? Explain your answer.
5. What do you think is the greatest threat to groundwater where you live?

What You Can Do...

1. Always dispose wastes such as used oil properly to prevent groundwater pollution. Take your used oil to a local gas station that recycles this material.
2. Have your water well periodically tested for contamination by your local health department.
3. All water well drillers are now required to be state certified and properly trained to construct wells in a manner that will prevent future contamination. Before your family drills a well make sure the driller is state certified.



Activity 5. Protecting Your Drinking Water
Instruction Sheet

DO YOU KNOW...

- Why contamination of drinking water supplied by public water systems in Kentucky has decreased dramatically for some pollutants?
- How much water Kentuckians withdraw from rivers, streams, lakes, and water wells each day?
- What the source of your drinking water is?

Drinking Water Quality Varies Throughout Kentucky

Kentucky is blessed with abundant supplies of water. And while you would think that we have enough to meet our drinking water needs, contamination and droughts have affected community drinking water supplies throughout the state.

Kentucky gets its drinking water supplies from 89,431 miles of streams and rivers, hundreds of lakes, and our vast sources of underground water, known as groundwater. Most drinking water is provided by public drinking water systems, which treat the water and distribute it via water lines to our homes and businesses. Groundwater supplies about 20% of the drinking water used by all Kentuckians.

Contamination of water treated and supplied by public drinking water systems has decreased for several pollutants. For example, instances of high levels of bacterial contamination, which is the most common pollution problem public drinking water systems encounter, declined 90% statewide during the last 10 years.

The improvement of drinking water quality is good news to all of us. But new threats, primarily man-made chemicals, are making their way into our drinking water. By learning more about our drinking water sources and pollution problems we can ensure the water we drink is safe both now and for generations to come.

Purpose:

In this activity you will analyze drinking water issues in Kentucky and the potential of pollution to affect your own supplies. You will also research where your drinking water comes from and conduct a survey to determine if your community is satisfied with the quality of your drinking water.

Procedure:

Part I - Becoming Informed

1. Obtain Worksheet #1 from your teacher. Review, discuss, and answer the questions.

Part II - Investigating Your Drinking Water

1. Divide into groups to investigate the source of your drinking water (river, stream, lake, groundwater, etc.) and how it is supplied to you (public system, private well, other). List some of the pollution threats to your drinking water source based on what you have read and your knowledge about water pollution problems in Kentucky.
2. Based on this information, each group will prepare a survey to determine if the general public is informed about their drinking water, where it comes from, if they think it is safe to drink, and what they think the potential pollution problems may be. Each group member will survey at least 3 people in the community.
4. Compile your group's survey results and present them to the class. As a class, compare the results and draw some conclusions about people's knowledge of their drinking water and its quality. Discuss ways individuals, businesses, and industries can help protect your drinking water supplies.
5. Based on your research and survey, each student should prepare a report about the importance of clean water, whether or not you and your community believe you have safe and clean drinking water, and what steps you think should be taken to protect drinking water supplies for the future.

Instructions continued

Part III - Getting Involved
1. Write a letter to your elected officials to share the findings of your research, survey, and concerns you have about your drinking water.

Other Activities:

1. Research the geology of groundwater in Kentucky. Determine what type of aquifer is in your region and its importance.
2. Research how a public drinking water system works. Sketch your public drinking water plant and label its parts, including the source of the water.
3. Visit a public drinking water plant including the laboratory where the water is tested.
4. If you live in a rural area that depends upon groundwater, invite a water well driller to discuss how wells are constructed today compared to the past and how wells should be maintained.

References/Additional Resources

Eighty counties are in the process of preparing long-range water supply plans to meet future drinking water needs. Contact your county judge/executive to determine if your county is planning for future water supplies and how you can become involved in the process.

Activity 5: Protecting Your Drinking Water
Worksheet 1

Drinking Water Quality Threatened By a Number of Pollution Sources

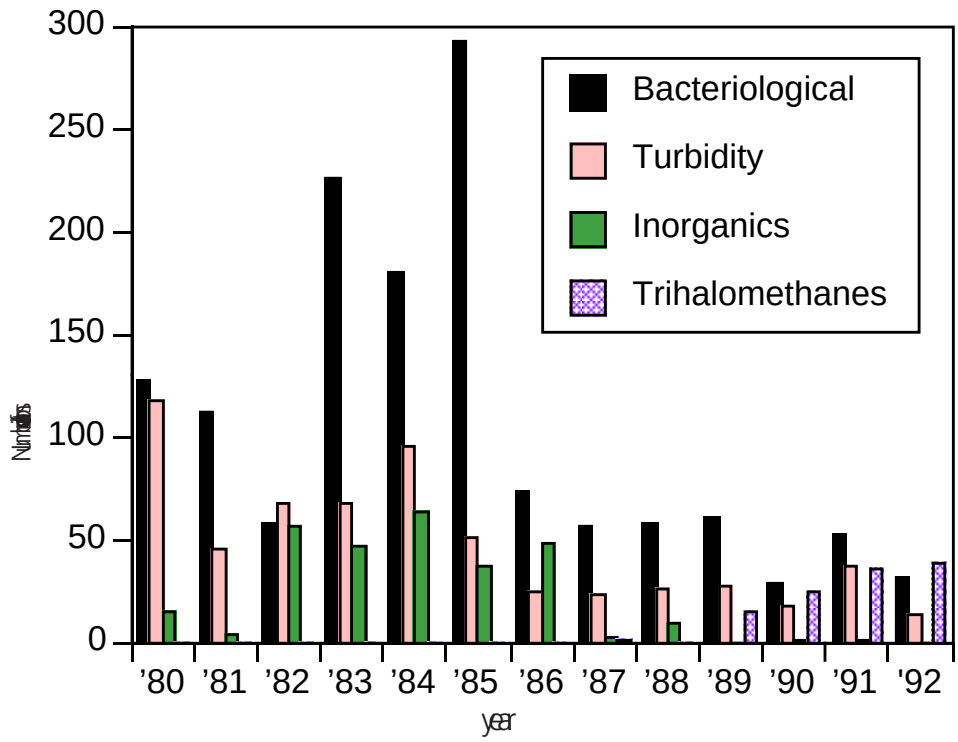
Surface and underground sources of water provide drinking water to the state's population of 3.71 million. While the quality of drinking water is considered good, new and improved methods of testing have revealed many potential threats to this resource, mainly in the form of man–made chemicals. Our drinking water comes from rivers and streams or from groundwater much of which contains pollutants caused by many different activities. These pollutants must be removed before the water is safe to drink. Removing pollution from water is expensive and often difficult.

The federal Safe Drinking Water Act, passed by Congress in 1974, regulates public water supplies to ensure the nation's drinking water is safe for use. Presently, public water systems must monitor and provide treatment for 60 drinking water contaminants. Newly proposed federal standards will increase this number to nearly 200 by the year 2000.

Drinking Water Quality Generally Good in Most Cases

Generally, water provided by the state's 859 public drinking water systems (defined as those that serve 25 or more people) meets the federal Safe Drinking Water Act standards. The standards are set to protect public health and focus on three general categories of contaminants: bacteriological, organic chemicals, and inorganic chemicals. Violations of drinking water standards have generally declined in Kentucky (Figure 1). The steady decrease in violations warrants optimism that drinking water quality is improving for many Kentuckians.

Figure 1
Violations of Selected Drinking Water Standards in Kentucky



Note; Data for trihalomethanes is not available for years prior to 1989
Source: Kentucky Division of Water, 1992

Worksheet 1 continued

Bacteriological contamination is one of the most common violations of drinking water standards in the state. Bacteria in the water is usually the result of improperly treated animal and human waste. Bacteriological drinking water violations have decreased steadily during the last 10 years as can be seen in Figure 1.

Drinking water violations of turbidity standards have also decreased in recent years. Turbidity, or cloudiness, caused by small particles of silt, clay, or other matter can interfere with the disinfection of water and can allow disease-causing organisms to survive. Systems must also monitor several inorganic chemicals such as nitrates that come from various sources, including fertilizer runoff from cropland.

Organic chemicals pose a potential problem to Kentucky's drinking water. These synthetic, or man–made compounds, can cause a range of health problems from skin rashes to terminal illness. This category of pollutants includes pesticides, herbicides, and volatile organic chemicals (VOCs) which are highly reactive, such as benzene found in gasoline. The Division of Water requires that public drinking water systems test for a variety of these chemicals, including six agricultural pesticides. Results of those tests have not detected any of these pesticides above drinking water standards in the treated water. Testing scheduled to begin in 1993 for 18 additional pesticides, including four that are widely used in Kentucky, will assist in providing a broader perspective of pesticide threats to public drinking water supplies.

Detection of Chemicals in Some Drinking Water Raises Concern

Public drinking water systems are also required to test for eight regulated volatile organic chemicals (VOCs) which are highly reactive. These chemicals are used in industrial solvents, degreasers, and cleaners. Monitoring conducted in 1987 revealed 60 public drinking water systems had measurable levels of one or more of the eight regulated organic chemicals. Six systems were discovered to be supplying water with these chemicals exceeding drinking water standards established to protect public health. Systems that detected high levels of these chemicals were required to treat the water or find an alternative water supply.

The detection of chemicals such as benzene, vinyl chloride, and acetone reveals that toxic and hazardous chemicals in drinking water are a potential threat to public health. Public drinking water systems must test for organic chemicals every three years.

Figure 2

Public Drinking Water Systems in Kentucky with Violations*

Facility Size (Population Served)	Number of Systems	Number of Systems w/ Violations	Number of Water Violations	% of Violations
<101	212	109	416	47%
101-500	201	93	233	26%
501-1,000	69	34	76	9%
1,001-2,500	131	37	51	6%
2,501-3,300	53	16	30	3%
3,301-5,000	50	10	17	2%
5,001-10,000	80	22	41	5%
10,001-50,000	56	14	18	2%
50,001-75,000	4	1	1	<1%
>100,000	3	0	0	-
Total	**859**	**336**	**883**	

** Includes violations of drinking water standards, monitoring, and reporting violations.*

Source: Kentucky Division of Water, 1992

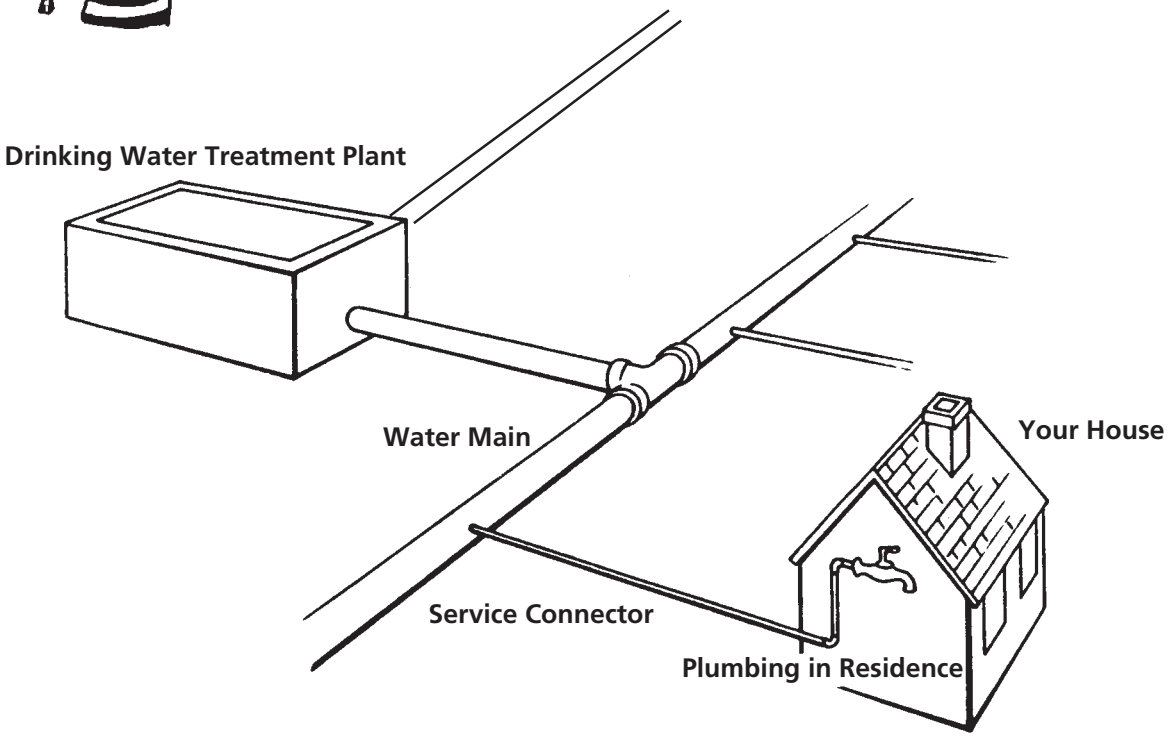
Worksheet Included

Another pollutant of concern is actually formed during the treatment of water for drinking. Disinfection by–products (primarily chemicals called trihalomethanes or THMs) are formed when chlorine reacts with decaying organic matter during the water treatment process. The federal government is expected to issue a more stringent THM standard within the next two years to further reduce the amount of these chemicals in drinking water to protect public health. This is necessary because THMs are thought to cause cancer.

Smaller Public Water Systems Greatest Violators of Drinking Water Standards

Systems serving 101 people or less are the greatest violators of drinking water standards in Kentucky (Figure 2). These systems generally cannot afford to improve their technology or hire full–time plant personnel. Many smaller public drinking water systems cannot meet drinking water standards because of inadequate equipment or improper operation and maintenance. The increasing cost of meeting drinking water standards has resulted in the merger of 336 small plants with larger systems since 1980. Many other communities have either repaired, or expanded their existing drinking water facilities, or built new plants. The merger of smaller and poorly-operated systems has clearly assisted in improving overall drinking water quality in Kentucky.

Public Drinking Water System



Adapted from U.S. EPA publication OPA-87-006

Worksheet #1 continued

Questions?

1. Which year appears to have been the "best" year to have a drink of water from an average system, based on Figure 1? Why?
2. List the steps you would take to protect your drinking water and explain your answers using the data in Figure 2 and other information available to you.
3. Do you think your drinking water is safe to drink? Explain why?

What You Can Do...

1. Conserve water and help others in your home learn how by installing low-flow toilets and faucets. Install low-flow showerheads and don't use too much water.
2. During the summer, a major amount of household water is used to keep yards green. To use water more efficiently, water in the early morning or evening to reduce evaporation. Lawns only need about one inch of water per week.
3. Protect your drinking water supply by participating in monitoring programs and cleanups.